UNITED STATES DEPARTMENT OF AGRICULTURE
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# DAFFODILS

By

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Bureau of Plant Industry

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## DEFINITION AND CLASSIFICATION OF THE DAFFODIL GROUP

The name "daffodil" originally referred to the trumpet, short, and medium-trumpet forms of Narcissus, but has now come to be coextensive with Narcissus. It is so used throughout this circular. The genus Narcissus forms a large and important part of the Amaryllidaceae, a family which includes in addition such important and well-known ornamental genera as Amaryllis, Galanthus, Nerine, Clivia, Eucharis, Vallota, and Crinum. It differs from the lilies in having the floral parts inserted on top of the seed vessel instead of on the stem below it.

The common names applied to the genus and its divisions are rather confusing. The generic name, Narcissus, is used as a vernacular and as a scientific name, both properly referring to all the members of all the groups.

The jonquils constitute a small group of rush-leaved forms, derivatives (fig. 1) of *Narcissus jonquilla.* In a florist-trade sense, however, jonquil is often improperly used to designate the trumpets. (Fig. 2.)

Attempts have been made to broaden the use of the word "narcissus," used as a common name, by employing the same form of the

[1] This circular is a revision of and supersedes U. S. Department of Agriculture Bulletin 1270, The Production of Narcissus Bulbs.

word for both singular and plural to obviate the awkward Latin and the still more awkward English plural form. The practice, which seems worthy of emulation, has not been generally adopted.

The daffodil has a very characteristic flower set on top of a leafless stem (scape). The stem is attached to the base of the seed vessel (ovary), and superimposed upon the seed vessel is the flower, which consists of a tube inclosing the pistil and stamens and bearing the six perianth segments.

In long-trumpet daffodils (fig. 3), such as King Alfred, it will be seen that the tube is wide and conical, and the perianth segments are attached to it below the middle. The trumpet is as long as the segments, wide flaring, and recurved at the rim. If a flower of a poeticus daffodil, such as Recurvus (fig. 4), is examined, the same parts will be seen, but they look quite different. The tube is long and narrow, and the perianth segments are inserted far from the ovary. The trumpet or corona is short, reduced, and flattened. The stamens are inserted on the tube as before, but in two series of three each, one near the throat and the other lower down.

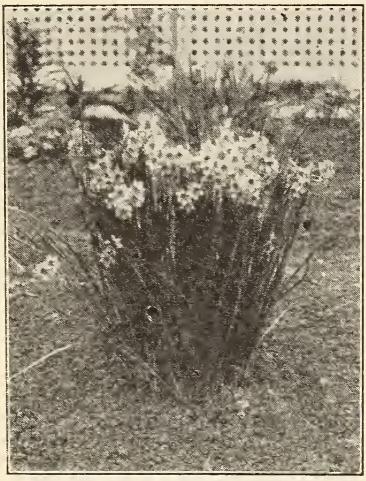

FIGURE 1.—*Narcissus odorus campernellii*, undisturbed in a herbaceous border for five years. Salem, Oreg.

Figures 3 and 4 may be taken to represent the conventionalized extremes of the flower structures. These two extreme forms have been hybridized and varieties produced which are known as the chalice-cupped, the Mediocoronati, or incomparabilis forms, in which the trumpet is midway between these two extremes, and the other parts of the flower are correspondingly modified. Subsequently intercrossings have obliterated these distinctions to a large extent by the production of varieties with all gradations between the mammoth trumpet of King Alfred and the small cups of the poets.

The confusion in the attempted classification of the host of garden hybrids led to the appointment of the daffodil nomenclature committee by the Royal Horticultural Society of London in 1908. This committee published a Classified List of Daffodil Names, which has been three times revised, the last issue being that in 1929 (*8*).[2] The report represents a tremendous amount of labor in bringing together and arranging alphabetically nearly all the names that have been given to daffodil varieties. Two lists are published, the first containing about 3,000 names in current use for varieties of daffodils, and the other about 2,000 more which for one reason or another are antiquated.

[2] Italic numbers in parentheses refer to Literature Cited, p. 73.

The classification is artificial, of course, and has been added to as experience in its use indicated was necessary. The genus is segre-

FIGURE 2.—The large-trumpet daffodils: Upper, left to right, Weardale Perfection, King Alfred, Glory of Noordwijk; lower, Olympia, Van Waveren's Giant. United States Bellingham Bulb Station, Bellingham, Wash.

gated into 11 divisions, based mainly on the relation of the perianth to the corona, and the divisions have been further subdivided on the basis of color.

The classification that follows is copied from the report of the committee. The writer has endeavored to add examples of well-known varieties to each class.

*Division 1. Trumpet daffodils.*—Trumpet or crown as long as or longer than the perianth segments.

*a.* Varieties with yellow or lemon-colored trumpets and perianth of same shade or lighter (but not white). King Alfred.

*b.* Varieties with white trumpet and perianth. Madame de Graaff.

*c.* Bicolor varieties, having white or whitish perianth and a trumpet colored yellow, lemon, primrose, etc. Glory of Sassenheim.

*Division 2. Incomparabilis.*—Cup or crown not less than one-third but less than equal to the length of the perianth segments.

*a.* Yellow shades, with or without red coloring on the cup. Sir Watkin.

*b.* Bicolor varieties, with white or whitish perianth and self-yellow, red-stained, or red cup. Cynosure.

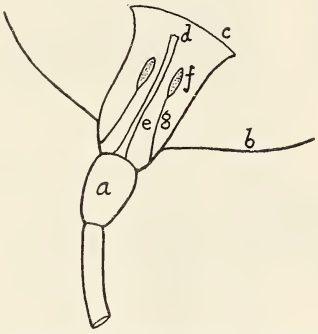


FIGURE 3.—Diagram of a trumpet daffodil flower: *a*, Ovary; *b*, perianth; *c*, trumpet; *d*, stigma; *e*, style; *f*, anther; *g*, filament

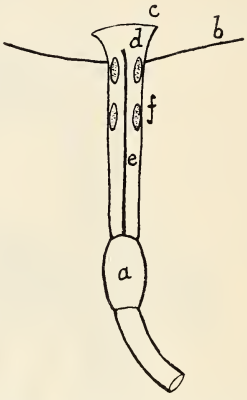


FIGURE 4.—Diagram of flower of poets narcissus: *a*, Ovary; *b*, perianth; *c*, cup or trumpet; *d*, stigma; *e*, style; *f*, anther

*Division 3. Barrii (incorporating Burbidgei).*—Cup or crown less than one-third the length of the perianth segments.

*a.* Yellow shades, with or without red coloring on the cup. Barrii Conspicuus.

*b.* Bicolor varieties, with white or whitish perianth and self-yellow, red-stained, or red cup. Lady Moore.

*Division 4. Leedsii.*—Perianth white, and cup or crown white, cream, or pale citron, sometimes tinged with pink or apricot.

*a.* Large trumpets, with cup or crown not less than one-third but less than equal to the length of the perianth segments. White Queen.

*b.* Small trumpets, with cup or crown less than one-third the length of the perianth segments. Ariadne.

*Division 5. Triandrus hybrids.*—All varieties obviously containing *Narcissus triandrus* blood.

*a.* Large crowns, with cup or crown not less than one-third but less than equal to the length of the perianth segments. Queen of Spain.

*b.* Small crowns, with cup or crown less than one-third the length of the perianth segments. Agnes Harvey.

*Division 6. Cyclamineus hybrids.*—Derivatives of *Narcissus cyclamineus.* Silver Cycle.

*Division 7. Jonquilla hybrids.*—All varieties of *Narcissus jonquilla* parentage. *N. odorus campernellii.*

*Division 8. Tazetta and Tazetta hybrids.*—To include *Narcissus tridymus,* poetaz varieties, Dutch varieties of polyanthus narcissus, *N. biflorus, N. muzart,* and *N. intermedius.*

*Division 9. Poeticus varieties.*—Contains the poets narcissus and the extensive list of garden hybrids. Poeticus Ornatus.

*Division 10. Double varieties.*—Double-flowered varieties of all groups included. Double Van Sion, poeticus Albus Plenus.

*Division 11. Various.*—To include *Narcissus bulbocodium, N. cyclamineus, N. triandrus, N. juncifolius, N. gracilis, N. jonquilla, N. tazetta, N. viridiflorus,* etc.

The classification is useful in various ways. Designed as it is primarily as a guide for exhibitions of daffodil flowers, it is indispensable for that purpose. It may also be employed in various ways to save wordy descriptions, in that a simple designation like *1–a* to the daffodil fancier immediately places the flower in question among the long-trumpet daffodils, which are all of the same or different shades of yellow. The list (*8*) is indispensable to the student of daffodils, if not to the serious amateur.

## HISTORY

No attempt need be made to cover the early history of the daffodil, for that has been well done by many competent authorities. A few references, however, are given in regard to the modern development of the daffodil and a few of the sources from which information may be derived. Nearly all of these give further references.

The treatise on the genus Narcissus by Burbidge and Baker (*2*) is classical and may well form a starting point for the practical gardener. It gives the history, classification, and complete exposition of the group and is copiously illustrated in color. Bourne (*1*) has given a résumé in book form with descriptions of the varieties, their uses, and cultural directions, based on intimate knowledge. Kirby (*7*), who has complete familiarity with the culture, merchandising, and forcing aspects, has covered the subject from an American viewpoint. His is the only American book on the subject. Jacob (*6*) published a very useful and popular book in 1910. Another very useful book is that published by Sydenham (*10*) in 1913. It is unique in that it gives not only cultural directions but also brief, concise descriptions of all varieties known to the author, together with prevailing prices. Hartland (*5*), of Cork, Ireland, is said to have issued the first catalogue of daffodils.

While it may not be necessary for the daffodil grower to have a copy of the Classified List of Daffodil Names (*8*), this work is indispensable to the student. It contains a list and classification of all names known to the authors, together with an outline of the system of classification and the names of the originators of the varieties when known.

One of the most comprehensive books ever written on daffodils came from the press in 1929. It was written by Calvert (*12*) and covers the subject admirably from the English point of view. Its main value to American horticulturists consists in its up-to-date estimates of the newer varieties.

The journal and the yearbooks (issued occasionally) of the Royal Horticultural Society, London, and the annual reports of the Midland Daffodil Society, Birmingham, England, contain in concentrated form

information on all phases of daffodil breeding, culture, use, and handling.

Catalogues of seedsmen and bulb growers present valuable information on the culture, characteristics, and adaptability of narcissus varieties. Some firms issue special bulb catalogues and others publish books of directions for the culture of narcissus and other bulbs.

Some of the most valuable information about daffodils appears in current periodicals and florist and other trade papers. Consequently, anyone interested in daffodils should read one or more garden or trade papers.

## DECORATIVE VALUE

There are few decorative plants so adaptable as the daffodil, or that can be enjoyed for so long a period. The Paperwhite (Paperwhite Grandiflora) can be made to blossom for Thanksgiving, and Recurvus and Alba Plena Odorata will blossom outside from late April to Decoration Day, depending upon the location and the latitude. Between these two extremes there need be no time without daffodils in flower either in the field, living room, conservatory, or greenhouse.

Daffodils proclaim the arrival of spring; they add both a boldness and a delicate, charming touch to the landscape; they are adapted to open woodlands, meadows, and rocky declivities; they are charming in beds and borders and may be employed even in the lawn and in the edges of pathways; they are most effective as pot plants for house decoration in soil, water, pebbles, or fiber; they have scarcely a peer as cut flowers when employed with their own leaves or almost any other greenery.

## COMMERCIAL IMPORTANCE

No better proof of the popularity and importance of the daffodil is needed than a bare statement of the quantities used in this country until recently. The numbers used have fallen off of late, but it is likely that they will come up again as supplies become more plentiful.

It is not possible to determine just what the consumption of bulbs and flowers is now, but in the recent past there were imported annually for decorative purposes, mainly for greenhouse and home forcing, 40,000,000 Dutch daffodil bulbs and about an equal number of Paperwhites and other tender varieties. Besides these there were many millions of blossoms cut and sold from out-of-door plantings. The value of the bulbs used in these ways was probably close to $2,500,000, and the expenditure for the cut flowers more than twice that sum.

Besides these quantities, the large numbers enjoyed in beds, borders, and other semipermanent and naturalized plantings are to be taken into account. Although there are sections of the country where daffodils are not grown and where the cut flowers are seldom seen, their use is very extensive and important.

## REGIONS TO WHICH THE DAFFODIL IS ADAPTED

While there is no region where all daffodils can be grown successfully, there are few indeed where some of the varieties can not be produced well enough to be enjoyed in the border, woodland, or meadow. The regions where they can be grown for decorative purposes are fortunately very much more extensive, and conditions are infinitely more varied than those adapted to the commercial production of the bulbs.

In any consideration of the geographical adaptability of the daffodils a sharp distinction should be drawn in the beginning between the tender polyanthus group and the more hardy trumpets, poets, etc. It has become customary to group these tender and hardy varieties as south France and Holland stocks, respectively, and free use is made of this rough classification in these pages. This has come about because it has been from these two regions that we have been accustomed to secure the two classes of bulbs. From southern France have come the Paperwhites, Grand Soleil d'Or, and Double Roman, especially, and from the Netherlands the vast majority of the other daffodils. From the warm regions about Amoy, China, has come the Chinese sacred-lily.

It is to the warmer regions, therefore, that this tender group must be rigidly confined. California, the Gulf States, extreme southern South Carolina, and Georgia are demonstrated possibilities. Attempts at the culture of this group are being made as far north as Wilmington, N. C. The hardy group is applicable to a still more varied series of conditions. The Dutch stocks are now produced in the Pacific Northwest, in the northern tier of States, in the Atlantic coastal plain as far south as the Carolinas, and in many interior locations such as portions of Illinois, Tennessee, and Indiana.

Naturally between these two extremes there is a wide area which may be looked upon as a sort of no-man's daffodil land, where both groups may be more or less satisfactorily grown, for decorative purposes at least but not commercially. Both the Paperwhite and the Chinese sacred-lily will flower at times as far north as Washington, D. C., and the trumpet daffodils are often seen in northern Florida, while the true jonquils and their derivatives can be grown in the South Atlantic States. Some of the so-called Dutch varieties produce better in the warmer portions of the Dutch daffodil belt than in the colder. This is particularly true of such forms as Gloria Mundi, and probably of Ard Righ and some of the poetaz varieties.

While the Dutch group in general may be said to be adapted to the Atlantic coastal plain, for instance, there are many qualifications, exceptions, and reservations that need to be made. There are two striking examples that should be noted of the most exacting requirements for successful production.

The old Lent lily, or Double Van Sion as it is now called, is one of the particular varieties. It must be grown where the atmosphere does not get hot during any portion of the year. Throughout the Atlantic coastal plain the flowers turn green and split excessively, becoming of little if any decorative value. The plants, however, are

healthy, and the bulbs develop quite satisfactorily, although it may take two or three years of good culture under adaptable conditions to bring the flowers back to normal. To produce this variety satisfactorily, one must resort to Cape Cod, Puget Sound, or some such region where the humidity is ample and the mean temperatures low. Many doubles, such as Holland's Glory and Double Sir Watkin, also turn green.

The conditions required for the satisfactory culture of Alba Plena Odorata are very similar to those required for Double Van Sion, but the reaction on the plant is very different. Either hot or dry weather will blast the flowers of the former. The variety was very commonly grown in yards in a small town in southern Indiana some years ago, but no grower ever saw a flower. It is very seldom that flowers are seen at Washington, D. C. It flowers satisfactorily in northern New York. In the cape region of Virginia it blossoms very early, before the hot weather comes on, and is said often to open 50 per cent of its blossoms.

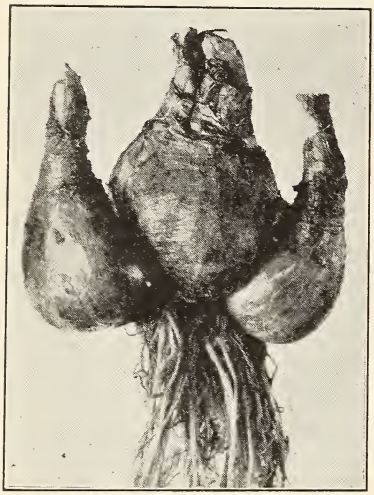

FIGURE 5.—Golden Spur from double-nosed bulbs left undug for two years

The ideal climate for the production of Dutch daffodils has a decided winter but no very severe weather. The best summer has a uniformly low average temperature without high heat. The rainfall should be copious during the growing season, September to June, and the atmosphere should have a relatively high humidity.

As these ideal conditions are departed from, difficulties of culture are encountered. High heat is especially detrimental during either the growing or the storage season. If heat or drought occurs during the growing season the growth is interfered with, but if hot weather occurs during the harvesting and storage seasons the bulbs are prone to rot. In short, difficulties of culture are multiplied greatly for the Dutch stocks as culture is attempted in regions having hot summers, which make necessary much more careful handling.

Fortunately a hot region, poorly adapted to commercial culture of the Dutch stocks, may be very well suited to the culture of the same stocks on a let-alone basis wherein the bulbs are disturbed but seldom and are grown with more or less of a protective covering of grass, leaves, etc., which shields the soil from excessive heat during the dormant season of the bulbs or during severe freezing in winter.

## THE DAFFODIL BULB

The bulb (fig. 5) of the daffodil is made up of closely appressed concentric layers not essentially different from those of the onion.

The scales are attached to a heavy basal plate, which the botanist looks upon as a modified stem. The scales are looked upon as thickened and enlarged leaf bases.

These analogies are perfectly borne out in the behavior of the bulb during reproduction, when daughter bulbs are formed, which are usually referred to as splits, slabs, propagation, or increase. When the bulb reaches a certain size, the maximum size for the variety, buds develop in the axils of one or more of the bulb layers, just as the bud develops in the axil of the leaf on an apple twig. They are homologous and comparable structures, but in the case of the daffodil the bud continues its development until it separates from the old bulb and becomes an independent entity, carrying with it a portion of the scales of the old bulb and robbing it also of a portion of the basal plate (stem).

The daughter bulbs in the daffodil contain or absorb a portion of the substance of the original or old bulb. In the daffodil, therefore, the old bulb persists indefinitely, being renewed or replaced by new leaf bases within and a transformation of the older outer layers into thin membranous coatings, finally useless except as protective coverings, which are abraded and worn off as the years advance. This is a very different condition from that found in the tulip, wherein a number of buds, 2 to 6 or 8, develop each year into new bulbs which are entirely new structures, partaking in no way of the structure of the old bulb, but being simply an outgrowth of it.

The development of the daffodil bulb is from within. Each season three or more leaves and the flower stem develop from the center. The dilated bases of these leaves become additional concentric layers, which push the old layers out as the season advances in proportion as they themselves expand, thus enlarging the size of the bulb and being themselves pushed outward another season.

## REPRODUCTION OF THE BULB

Before a grower is in a position to produce daffodils intelligently, he must have in mind clearly the behavior of the different categories of the bulbs. Not that the growth is fixed and definite, for it varies as with all living things; but there is a general plan which is after all quite uniform.

In Figure 6 (Golden Spur, which may be taken to represent the Dutch daffodils generally) are represented four categories of bulbs, namely, splits, round, double-nosed, and mother bulbs. In general it may be assumed that one season's culture will transform one of these classes into the next one above it, so that the cycle of development from a good-sized split to a well-divided mother bulb, which will contain several splits, will be three years.

This may be taken as the general method of development and growth. The method is, however, varied. The behavior is different in different varieties. Some conform very closely to the procedure outlined above, producing at the end of three years quite uniformly only one or two offsets. Other varieties at the end of three years may yield three or four times that number.

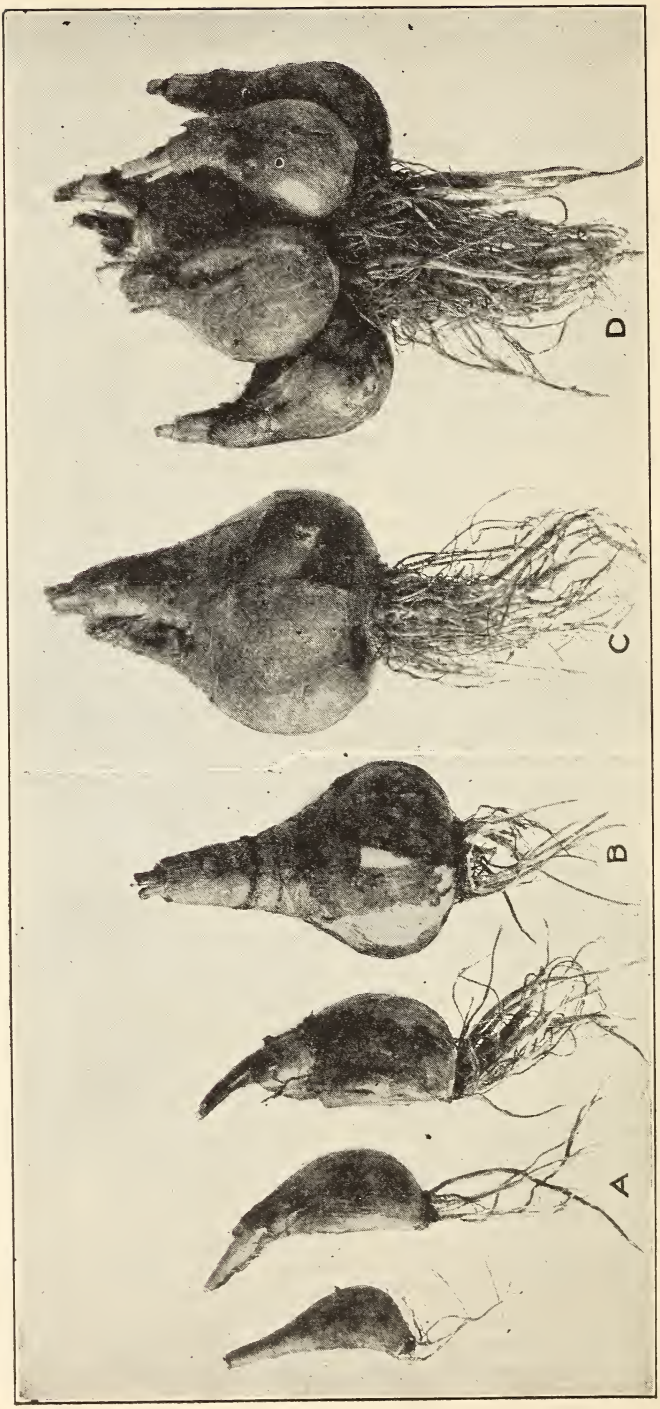


FIGURE 6.—Golden Spur bulbs: A, Slabs; B, round; C, double-nosed; D, mother bulb

The reproduction in the Paperwhite and Chinese sacred-lily (fig. 7) is not essentially different from that described above, but the number of splits produced is very large, and they are inclined to take place early.

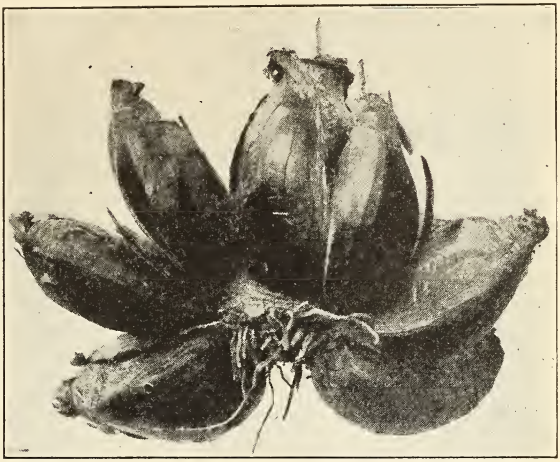

FIGURE 7.—Chinese sacred-lily bulb grown on heavy, moist land at Doctors Inlet, Fla.

At 1 year of age the seedling of the preceding year will be found to be round and symmetrical or slightly elongated. (Fig. 8.) During the second and third years the bulb becomes decidedly elongated, because of the influence of the long, stout, contractile roots, which proceed directly downward and pull the bulb down to the proper depth from the shallow position of the germinating seed. About the fourth or possibly not until the fifth year the seedling bulb will have assumed the aspect of a mature bulb, will be round and symmetrical, and will have attained a circumference of 12 to 15 centimeters.

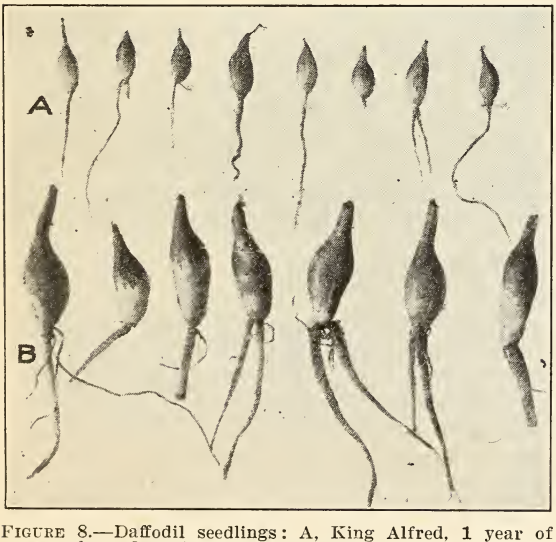


FIGURE 8.—Daffodil seedlings: A, King Alfred, 1 year of age, about 2 centimeters in circumference; B, Glory of Noordwijk, 2 years of age, about 4 centimeters in circumference. Note elongated bulbs

If such a bulb is cut open transversely late in the season a division is very likely to be found already outlined. The next (possibly the sixth) year a double-nosed bulb results, and the seventh year a split may be taken off, commonly still a double-nosed bulb, which will go through the cycle of development already described.

## SOIL PREPARATION

For good results the soil in which daffodils are planted should be naturally friable and well and deeply cultivated. The importance of this will be seen when it is realized that the roots go down in soil of the proper tilth 12 inches or more, and the bulbs are all covered

with 4 inches of soil. It is evidently necessary to have the soil in tilth to such depth that the roots can penetrate easily and without getting into water standing over a hard impervious subsoil. Thorough pulverizing, rendering the soil friable and of easy penetration by moisture, is imperative. The necessity for such preparation will be all the more apparent when it is realized that there is opportunity for deep culture only once in two years when a year is missed in digging or in case of cut-flower production at even longer intervals.

A daffodil bulb can not develop as it should in soil that packs or solidifies around it. Its development is arrested by hard-soil pressure, so that the bulbs do not attain proper growth. This has been witnessed time after time at the United States Bellingham Bulb Station at Bellingham, Wash. Even with good and deep tillage the packing of the soil in autumn by the liberal use of a hand tractor has reacted to reduce the development of the bulbs.

The grower should not be satisfied with a ground preparation less than 18 inches in depth. Of course it is not always practicable to attain this depth all at once, but it should be the aim to reach it as soon as possible. The plowing should be deep, and a subsoiler should be used after the plow. There should be no chance for the accumulation of water within 18 inches of the bulbs.

## BENEFIT FROM CHANGE OF LOCATION

Daffodils are not exacting in their soil requirements. They are successfully grown on both sandy loams and quite heavy clays. Nor is this adaptability restricted to any one group. It holds for both the Dutch and the French stocks.

However, it is well recognized that the Dutch stocks especially are greatly benefited by a change of conditions. If they have been grown for some years on a heavy soil they increase in vigor, condition, and productiveness if grown for a season or two on a sandy loam. Likewise stocks grown on sandy loams are benefited by being transferred for a period to a heavier soil. The stocks seem to be invigorated by a change of soil conditions. Some growers in the Northwest are alternating between sandy loam and peat soils with apparent success.

## PLANTING

Like other crops of wide adaptability, daffodils may be planted in many ways. As yet there is no best way. At least, it has not yet been determined what way is best for this country. Many methods are in use and are likely to be for some time to come.

In both large commercial and small operations in the Netherlands the bed method is in vogue, and it has been employed to some extent in this country. It has the advantage of being exact and compels the most intensive use of the land, but it is expensive in hand labor.

The plan is best carried out in rectangular plots 30 to 50 feet wide. The length of the beds is the width of the plot. The beds, which are 3 feet wide with 12 to 18 inch paths between, are carefully laid off for the entire plot. The beds are marked off with a

spade along taut lines drawn along each side, the spade being thrust vertically into the soil to a depth of 2 to 4 inches and then pulled inward toward the center of the bed. The soil is thrown out of the first bed to a depth of 3 to 6 inches, depending upon the size of the bulb to be planted. The bottom is then raked level and a marker run through to place the rows, which are mostly 6 inches apart.

FIGURE 9.—Bed planting of daffodils

Two boys working on their knees on either side of the bed set the bulbs. The planting is then covered with soil from the next bed; thus one bed is opened and the bulbs in the other are covered in one operation. This process is repeated over the entire plot. (Fig. 9.)

A good crew for this plan of planting consists of two men and two boys. One man opens a bed and covers the bulbs in the other, and

FIGURE 10.—Row planting of daffodils in furrows

one rakes the bottom of the bed and applies fertilizer if any is to be applied. The two boys run the marker, keep a record of the planting, and set the bulbs. A third boy can often be profitably employed to mark off the beds and assist where needed in the other operations.

Another good way is to plow the bulbs in. (Fig. 10.) To do this it is necessary to arrange the hitch so that the horse walks on the

unplowed land. A plow is employed to give the width of row desired, and the bulbs are set in every furrow.

At the Bellingham Bulb Station a 10-inch plow is crowded to give about a 12-inch row. The implement has been modified in several particulars and is considered to be quite successful. (Fig. 11.) It has an ordinary stubble moldboard, to the distal end of which has been bolted a moldboard from a 6-inch hand-tractor plow. This pushes the soil over farther, thus leaving the land level. Attached to the inside of the land side and braced from the furrow-side handle is a piece of heavy strap iron, which makes a mark in the base of the furrow slice where the bulbs are to be set. Attached to the beam is another strong piece of strap iron, to which is hung a small drag which marks the position of the next furrow. There is also attached the ordinary wheel guide to gauge the depth of the plow. The soil is all turned one way, which necessitates driving back empty each time, unless one wishes to work the area in lands, with a back and dead furrow in each.

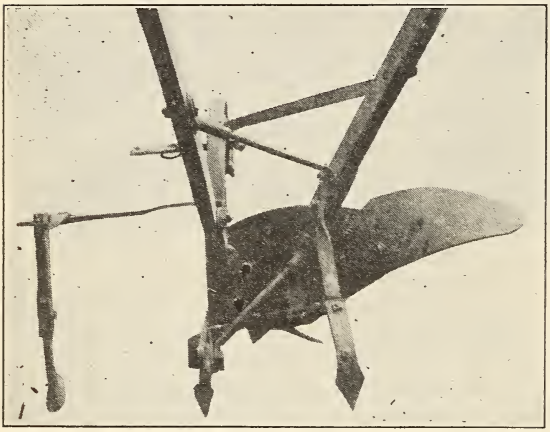

FIGURE 11.—A 10-inch plow adapted to plant daffodils in rows

Eventually perhaps some of our implement companies will adapt the sidehill-plow principle to an implement adapted to the planting of daffodils and other bulbs. This would necessitate a modification of the type of moldboard, the substitution of a light wooden beam, and a steel instead of the heavy cast construction usually employed at present.

Probably the majority of daffodil bulbs in this country are planted in rows by means of some form of shovel attachment which opens up a furrow of proper depth for setting. Often these are used in gangs to open up as many as four rows at a time. (Fig. 12.) At times sweeps are employed to open up a wide space wherein two or three rows are set close together, thus making in effect a narrow bed with wide spaces between. The double and triple rows are commonly set 3 feet on centers for power digging.

Some growers have adapted a potato planter to the planting of narcissus bulbs. The greatest objection to this is that it is not possible by its use to set the bulbs up, which is especially disadvantageous with the larger sizes.

## PLANTING FOR ORNAMENTAL PURPOSES

Planting for ornamental purposes is not essentially different from planting to produce bulbs commercially. Commonly, however, somewhat more care should be taken to plant the bulbs a uniform dis-

tance apart and at a uniform depth. In formal bedding these two factors are quite important, for uniformity of blossoming can not be attained with different depths of planting.

Where beds and borders are to be solidly planted to daffodils, it is a good plan to excavate the space as one would a bed in the Dutch method and then work the bottom thoroughly, incorporating whatever fertilizer has been decided on. If the bulbs are large, it may be necessary to set them with a trowel, but it is much easier to get uniformity if 3 or 4 inches of the surface are removed.

The common method is to set daffodil bulbs in tilled soil with a garden trowel, and this serves most purposes very well. It is a little difficult, however, to get the uniformity necessary this way when the bulbs are set 5 or 6 inches deep.

A great deal of ornamental planting is done with a dibble, which may be improvised by sharpening the broken end of a D-handle spade. The ground must be soft before this tool can be used advantageously. It is thrust into the soil and then wiggled around until the hole is large enough to let the bulb down to proper depth.

FIGURE 12.—Planting Paperwhite narcissus bulbs in southern California. Four rows, 36 inches apart, are opened at one time

The bulb is then put in and covered by pulling some of the surrounding soil over it. Some growers object to this method on account of the empty space left under the bulb. It may be said that the space is always moist and never persists longer than part of the first winter. This probably is not a very serious matter. On the whole, dibble planting is not satisfactory for most of the large commercial daffodil bulbs, but it answers better with the smaller sizes.

### NATURALIZED PLANTINGS

Planting daffodils under noncultural, ornamental conditions differs decidedly from the geometrical arrangements of beds, whether for commercial or ornamental purposes. It takes place mostly in firm, undisturbed soil, is preferably if not imperatively unconventional, and it is done where there is more or less competition from other plants.

Everything considered, the mattock is about as satisfactory a tool as can be found for use in planting in grass or other natural situations, provided the ground is not too firm and the soil is not too tenacious. The bit should be thrust the full length, then the slice

pried up sufficiently to get the bulb down to the proper depth. It does not matter if it is at an angle, but the neck of the bulb should be 4 inches deep and preferably 5 or 6 inches for best results.

If bulbs are large and the sod tough, a spade may work better for the same kind of a planting. The blade is thrust in full length at an angle of 45°, then pried up so that the bulb may be shoved down under the back to a proper depth. When the tool is removed the sod is pushed back into place with the pressure of the foot.

Often it is desirable to remove a sod of greater or less size, work up the subsoil, set the bulbs, and return the sod to its place again. This has decided advantages where the turf is tough and the subsoil hard or lean, for bone meal or other fertilizer may be easily incorporated as the soil is being worked up.

A dibble may also be employed for planting in grass, provided the sod is thoroughly wet just before planting, and provided further that the bulbs are small. In such an operation it is necessary to fill the hole above the bulb with foreign soil. If the planting is reasonably thick it is advisable to dump a barrow load of good soil on the dibbled-in area and then scatter it, filling the holes with the back of a rake. This not only covers the bulbs well but also helps the grass. The main objection to this plan is that it is difficult to get the bulbs deep enough.

While a geometrical design is advised for both commercial and formal bedding, it is the last thing to be desired in naturalized plantings. Informality and irregularity should be the watchwords. Lack of regularity fortunately is not difficult to attain. Even where sod is removed over a definite area, the bulbs when set can be informally arranged so that straight lines, uniform curves, regular angles, or uniform densities are avoided.

Little need be said of the scenic advantages to be derived from the utilization of daffodils in the landscape, in open woodlands, in glades, on stream banks, and in other settings where they are not disturbed for years. A number of such extensive plantings are familiar, some of which have functioned for a century with little care or attention. In foreign countries such use of the daffodil is much more prevalent than in the United States. It is from such plantings that inspiration for much of the poetical appreciation of the daffodil has come.

There are two particularly striking and extensive examples of the commercial utilization of naturalized plantings of daffodils in this country. One is in tidewater Virginia (fig. 13) and the other in southern Illinois (fig. 14). In both cases the bulbs have been left undisturbed in grass for 10 to 20 years. In the former location Spurius (Trumpet Major) has been employed, and in the latter Emperor, Empress, Conspicuus, Ornatus, Sir Watkin, and Golden Spur. Such handling produces mediocre flowers, which, however, have been consumed in large quantities in midseason and late season. A variety similar to Golden Spur is occasionally naturalized in the State of Washington (fig. 15), and there are less extensive naturalized areas in many States, particularly in Ohio, Georgia, Tennessee, and Oregon.

Aside from the occasional partial harvesting of the flower crop, naturalized plantings, or plantings allowed to go to grass for five or more years, have another important commercial aspect. Such plantings may be made the basis and source of stocks for field culture.

It is well recognized that stocks cultivated and handled annually for a long time are wonderfully invigorated when naturalized for a period of years. The bulbs dwindle in size to such an extent that they are

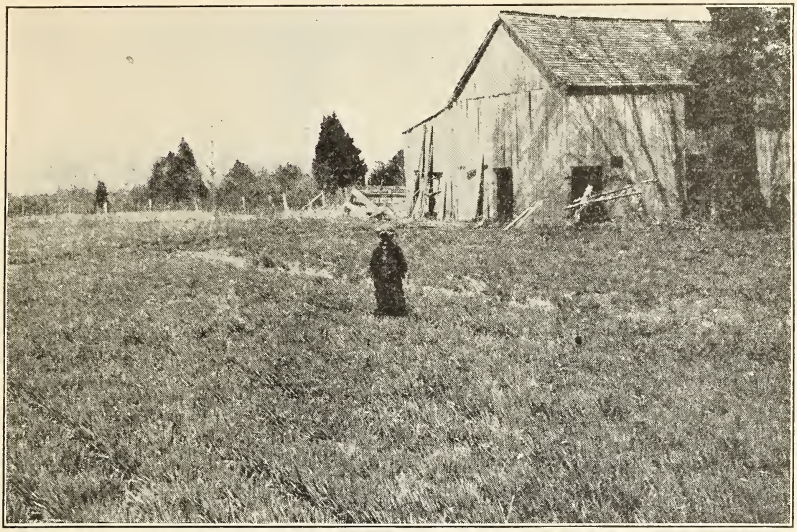

FIGURE 13.—An old naturalized planting of Spurius in Virginia. The planting has been undisturbed for 14 years

scarcely recognized as the same varieties, but when again brought under culture they come up to commercial size very rapidly and show increased vigor. This sort of handling is said to have been practiced especially with Golden Spur in the Netherlands.

FIGURE 14.—Emperor in sod undisturbed for seven years in southern Illinois

There has been opportunity to study several such naturalized stocks during the past 10 years. Experience with them agrees with the general verdict that the stocks are improved by such periods of non-handling. Double Van Sion of this character from Virginia was

handled in 1917, and Spurius from the same region later. Emperor, Ornatus, and Sir Watkin, from southern Illinois, were received in 1922.

In order that such naturalized bulbs may be again utilized in commercial cultures, it goes without saying that the varieties must be planted separately. Even for ornamental purposes this practice is desirable because of the better effect of solid colors and also because of the uniformity in season of blossoming.

## DISTRIBUTION OF PLANTING MATERIALS

For any uniform distribution of the bulbs at planting time it is necessary that they be carefully sized in some such way as that described on page 29 and the following pages. This is important in order that the turn off at the next digging may be estimated, because the crop should be sold long before it is dug. In intensive methods of culture, such as the bed system presupposes, uniform distribution for the purpose of cropping all areas alike and to the limit can be attained only by uniform sizing. Uniform cropping may not be so important a factor in the extensive American systems, but it is important in any planting to be able to forecast at planting time the crop to be dug.

The actual sizes made may vary greatly. The moderate grower without machinery may size his bulbs by hand quite rapidly and with a measure of satisfaction into splits, rounds, and double-nosed, in both Dutch stocks and the polyanthus groups. However, four or five sizes are much more accurate and satisfactory.

Each grower must work out his own segregations, and they must be close enough to give a fairly accurate picture of the harvest to come and to accomplish a uniform loading of the land. The segregations practiced at the United States Bellingham Bulb Station for both bed and row plantings will be of suggestive value to the grower in the adoption of sizes suited to his conditions and practices.

The sizes, although not always the same, have been mainly five in number, 6 to 8 centimeters, 8 to 10 centimeters, 10 to 12 centimeters, 12 to 14 centimeters, and over 14 centimeters in circumference. For the heaviest cropping in beds the first size mentioned may be set 35 to the 3-foot row, the second 21, the third 14, the fourth 11, and the fifth 9. If bulbs smaller than 6 centimeters in circumference are planted they may be strewn along at the rate of 50 to the row, and large double-nosed bulbs may be set 7 to the row.

These spacings represent very heavy setting, probably the limit under heavy fertility, and possibly a little too heavy under most conditions, in that there may be danger of the foliage maturing and dying prematurely because of poor aeration. The planting can be thinned in two ways. The number to the row may be stepped down one notch, or the rows may be made 9 inches apart instead of 6, or both methods may be adopted.

In 12-inch row plantings at the United States Bellingham Bulb Station it has been the practice to set the large bulbs about three to the foot and the other sizes progressively closer until the 6 to 8 centimeter bulbs are placed only half an inch apart. When those below 6 centimeters are planted they are often distributed thickly without definite placement. Bulbs smaller than those which would be planted 11 to the row are not usually set up.

The Paperwhite, the Chinese sacred-lily, and the French Soleil d'Or produce a larger top growth, are more vigorous, and must be given more room than most of even the large Dutch stocks. In row

FIGURE 15.—An old variety closely resembling Golden Spur, which has been undisturbed in this position for 20 years. It has been in the United States for 40 years. The past 3 years it has been cultivated somewhat, and is now sold as Pacific Spur

FIGURE 16.—Paperwhite narcissus plantation in Florida. This is the second year without digging of forced bulbs. Cowpeas were sown over these as soon as the tops died the first year

planting (fig. 16), such as is universally practiced with these varieties, there is little danger of overcrowding because of the wide interrow spaces.

## USE OF FERTILIZERS

It is always the safest plan for the grower, unless he has had enough experience to be considered expert in daffodil culture, to see to it that the ground planted is sufficiently fertile; that is, moderately fertile for ordinary crops without the addition of any animal manures at the time of planting. If such land is not to be had, the safer plan is to apply manure, grow some other crop on it the first year, and then plant daffodils. It is not intended to convey the idea that it is not possible to apply manure to this crop at the time of planting, but only that such practice is fraught with danger unless it is carried out with rare judgment. If manure is applied, it should be applied in moderation. It should be well decomposed and fine, so that the incorporation can be well-nigh perfect, or it can be plowed under very deep; otherwise basal rots are likely to be induced by the action of the fermenting particles in the soil, from the effect of which the young roots soon decay, and this decay extends to the base of the bulb.

The time was when the writer had no hesitancy in using horse manure as a top-dressing during the winter for daffodils. In recent years, however, a liberal use of 1-year-old leached material has proved to be the cause of much rotting of the stocks, so that now he is inclined to advise the elimination of such fertilizer unless an intervening crop can be grown. Such cautions do not apply with so much force to cow manure, but even with that daffodils may also be injured by poor incorporation of the raw fertilizer. In short, it is better to keep animal manure in a raw condition away from daffodil bulbs.

Experience with commercial fertilizers is too limited yet to serve as a basis for very definite recommendations, but a few factors are fairly well established.

The requirements that have been established for a potato crop in any particular region will serve as a fairly satisfactory guide for the fertilization of daffodils. Sulphate of ammonia is preferred to nitrate of soda, and at least a part of either should be replaced with some organic source of nitrogen. For the small grower who uses ready-mixed material a 4–8–10 formula[3] is suggested, but a much heavier application of potash is often used.

One English authority advises for daffodils 1 part by weight of kainit, 2 parts mineral phosphate, one-half part nitrate of soda, and one-fourth part iron sulphate. This is mentioned on account of the inclusion of iron, which has been recommended in this country by some and is recommended for the chalky, iron-deficient, leachy soils, but probably is seldom needed in this country, where iron is abundant.

The writer has felt well satisfied with a chemical fertilizer applied at the rate of 800 pounds to the acre on top after planting, with 1,000 pounds of commercial raw bone meal plowed under before planting. This was for very heavy cropping.

The quantity applied and the time of application will vary with conditions. On lean, leachy soils two and possibly three applications

[3] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

are to be preferred, one at planting time, one two weeks before blossoming, and the other three or four weeks later.

The total application per acre will vary with the natural fertility of the soil, the method of application, and the density of the crop. In intensive bed culture in the North, or in the 15-inch row culture of Paperwhites in the South, 1 ton to the acre is common usage, and twice this quantity seems to have been used with profit on southern sands.

## CULTIVATION

The cultivation of daffodils when planted in beds is a comparatively simple matter and is neither burdensome nor irksome if the labor is performed punctually. Contrary to the general belief, but little handwork is necessary on the beds except with certain varieties which are weak growers, do not cover well, or do not, for any reason, make thick or perfect stands. Toward spring the use of the weeder knives must be dispensed with, and some form of scratching or harrow attachment should be used in the cultivation.

After the plants are 2 inches high no form of wheel-hoe cultivation is practicable on any miscellaneous planting of daffodils, and with most of the vigorous varieties none is necessary, for soon after this they cover the ground so as to keep weeds down quite well. Weeds can not be much of a factor in a heavy crop. After this there is a reversal of the cultivation. Weeds will still grow in the paths, where there is less shade and competition. The cultivation before the plants are up is done across the beds usually, but after this it is directed along the paths only.

When the variety for any reason does not cover the ground fairly well by the time it is in blossom, handwork is necessary. In this case a light narrow hoe with the blade about 3 inches wide is preferred to be used between the 6-inch rows. A 3-prong cultivator hoe is also employed. One good job of cleaning out the weeds is usually all that is necessary even under those conditions.

In regions where weeds grow all winter the case is different, and the bed system, to a proportional degree, is less advantageous.

When the planting is in narrow rows, the autumnal cultivation need not differ from that of the beds, and weeder knives may be employed until the plants come up close to the surface. After that a scratcher attachment may be used. When the plants are up so that the rows can be followed, a wheel hoe or a garden tractor with attachments to cover several rows may be employed.

Cultivation, wherein the wide row is employed, is more difficult in autumn before the plants are up, unless the position of the row is kept permanently visible by the ridging of the soil over it or by some other method. This practice is commonly employed. Then cultivation can take place between the rows without injury from horses walking on the bulbs, which should never be allowed because irreparable injury is done by an animal footfall over a bulb in soft ground.

One element in the cultivation of bulbs is likely to be lost sight of if culture is on heavy soil and precipitation is inclined to be copious. It should never be forgotten that daffodils require a friable soil for

proper development. It is very easy to pack certain soils with hand-tractor or horse-drawn tool cultivation so as to interfere with the proper growth of the bulbs. The Bureau of Plant Industry has experienced just this kind of difficulty on the rather heavy silt soils at Bellingham, Wash. It is necessary in this location to do a large amount of work on the plantings in autumn to keep down weeds. The use of a hand tractor in the fall has packed the soil so badly that it has been abandoned. On friable sandy loams the packing injury would not be so serious, but the possibility should not be lost sight of.

The greater part of the cultivation of daffodils should be done before the bulbs are planted. There should be little need for further cultivation except to keep down weeds. Indeed, in a thick planting there is little opportunity to cultivate deep enough to pulverize the soil to any appreciable depth. Consequently, any practice that tends to pack the soil about the bulbs should be avoided. In wide rows, on the other hand, the situation is quite different, for the wider spaces permit of deeper cultivation.

## ROGUING

Inadvertent mixtures are prone to take place in bulb culture. For this reason, if for no other, two crops of daffodil bulbs should not succeed each other on the same ground, for there is no surer way of mixing stocks. During the time the plants are in blossom any stray individuals not of the desired variety can most easily be detected and removed by the use of a special spud which has a long stout blade, 2 to 2½ inches wide, set in a strong handle. Several examinations of the plantings are necessary during the season, each bed being gone over to detect plants that are growing in other than their proper places. In removing the plants the spud blade is driven down close to the bulb, then by prying on the handle the roots are broken off, and the whole plant may be pulled up easily.

This process of roguing is a very important one, not only in daffodil culture but in the culture of all bulbs, for if the grower neglects this aspect of the work his stocks are likely to get into such condition that they can be sold only as cheap mixtures.

Not only should plants of another variety be rogued out of a stock, but runty or otherwise imperfect bulbs should be taken out at the same time. There is a tendency for undersized and otherwise imperfect bulbs to accumulate if the grower depends largely on mechanical sizers and little on hand picking when bulbs are dug. To keep stocks up to vigor and type, advantage should be taken of every opportunity to get rid of the unfit.

What should be done with the rogues will depend entirely upon circumstances. Wherever they are identifiable and of desirable varieties they can be segregated and heeled in at the ends of the beds or rows in which they belong. When dug they can be included with the planting stock and will make first-class bulbs after another year's growth. More often, though, the rogues are heeled in together in some out-of-the-way place where they can be disposed of when dug as the cheapest of mixtures. The runts and otherwise imperfect or diseased plants should be destroyed.

## MULCHING AND OTHER PROTECTION

The covering of daffodils for winter protection has been little resorted to in any portion of this country. The practice will probably never be followed here because on the extensive scale on which the crop is grown mulching will scarcely be economically practicable. It can be done only with the most intensive culture. Situations in which mulching is necessary may not be able to compete commercially with areas where mulching is unnecessary.

There is no question but a mulch would be beneficial, as, indeed, it would be with many crops, but it is not imperative and probably is not economically feasible under our present conditions on general daffodil crops.

On seedling beds for the first two or three years a mulch is considered imperative. The reasons here are entirely different. The first year the seed, set but an inch deep, needs to be protected from soil disturbance, and for the next year or two from the bad effects of low temperatures on the shallow and delicate bulbs.

The material for such a mulch may be any form of litter, but one of medium coarseness is preferred. Straw or coarse hay is good. The Bureau of Plant Industry has used rye cut just before being mature enough for the seed to grow. This has been dried and tied into bundles of ordinary size and piled away for the purpose. It is easily applied in early or late autumn and removed again in early spring to allow the plants to come through.

In regions having hot summers, whenever bulbs are left undug it is considered necessary that they receive protection in some form. Dormant bulbs in moist or wet soil whose temperature may get up to 90° F. are likely to suffer. The cheapest and probably the best form of protection in such cases is a growing crop. Cowpeas or soybeans are successfully used and are probably as good protection as can be devised. If the planting is in rows, the seeding can be done while the plants are still green so that the soil is fairly well shaded by the time the daffodil tops are dead.

It is usually necessary to remove such a crop in late summer. Were it not for interference with future cultivation it could be lightly disked in and would serve a useful purpose in adding fertility. It would usually interfere too much with autumn culture for keeping down weeds, and consequently is better removed.

## REMOVAL OF FLOWERS

In tulip culture the removal of the flowers is imperative, but in the daffodil the matter is not so important. The objects of flower removal are two in number—to prevent spread of fire blight through decaying of the old flowers, and to prevent seed production, which absorbs too much of the energy of the plant.

In 10 or more years of experience at Bellingham no case has been observed where it was thought that injury resulted from spread of disease by the decaying inflorescence. The seeds produced there are few in number and are confined mostly to the large trumpets. Aside from King Alfred, Van Waveren's Giant, Glory of Noordwijk, Weardale Perfection, Great Warley, Glory of Sassenheim, and Spring

Glory, the seed production has thus far been negligible in the 150 or more varieties grown. The flowers should by all means be removed from these, but in the Leedsii, Barrii, poets, and the long list of incomparabilis, it does not seem to matter.

In Virginia and North Carolina the seed production has been even less than at Bellingham in the good seeders mentioned, but some production is to be noted for a few of the newer varieties in Virginia.

In the culture of the Paperwhite, Grand Soleil d'Or, and Chinese sacred-lily in Florida, it is believed that benefit would result from the removal of the flowers, but at the northern limit of Paperwhite production, so far as observed, seed is seldom produced in sufficient quantity to amount to much.

## DIGGING

The digging of daffodils does not differ essentially from the digging of many other bulbs. The operation will vary somewhat,

FIGURE 17.—Digging daffodils in the bed method of planting

however, with the locality and the nature of the soil. In the Pacific Northwest, where the digging occurs before the tops are thoroughly dead and while the roots are still green, it is advantageous to hoe the tops off before digging is begun. In the South, where the tops go to pieces so quickly after they ripen, there is no interference from this source.

If the planting is in beds, the digger starts at the end of the bed with a short-handled spade and takes out row after row in succession. (Fig. 17.) In heavy soils like the Whatcom silt, upon which the investigational work of the Bureau of Plant Industry is being conducted, it is necessary to remove a layer of soil 6 inches wide and about 2 inches deep across the bed by sticking in the tool and pulling it toward the digger. This commonly exposes the tips of the bulbs, which can then be removed one or two at a time by another thrust of the spade. In a friable sandy-loam soil one thrust of the tool is all that is necessary to remove two or more bulbs.

The bulbs are placed in windrows in the paths as dug and remain there until dried out somewhat, when they are covered with débris of old tops hoed off the beds. How long they remain in the windrow and how they are handled there depends upon weather conditions, facilities for handling, and other factors. In the Puget Sound region the bulbs can usually remain exposed for a day or two if it is not extraordinarily hot. If, however, the bulbs are small and free from soil, they should be watched very carefully, for even in this cool climate some varieties are likely to be injured by the sun. In heavier lands the bulbs come out of the ground with a great deal of soil on them and are consequently not so easily injured. Sir Watkin bulbs, especially in the smaller sizes, are likely to be injured even on Puget Sound. In the Virginia and other regions, where the sun's rays are more effective, the bulbs should not be sunned at all, for an hour of strong sun will almost ruin many daffodil bulbs which are exposed.

If the planting is in narrow rows a proper-size plow is employed in digging, the whole plot or parcel of ground being turned to a depth to just clear the base of the bulbs safely. It is usually advantageous to use a plow larger than the width of the row. A 16-inch plow does very well to plow out 12-inch rows. No colter is used, the plow being run not midway between the rows but as close to the one being plowed out as is possible without injuring the bulbs. If the ordinary stubble moldboard is employed and the plowing is carefully done, the bulbs will be placed on top of the soil with the roots uppermost and plainly visible.

Pickers follow and pick up the bulbs from the furrow slice, put them in windrows as before, or into containers to be carted to the storage house.

In wide plantings the rows are sometimes barred off before being plowed out. Usually, however, in such a planting a modified potato digger is employed. It is operated just as in the digging of potatoes. The use of this tool is conditioned largely upon the soil's being friable so as to reduce draft and permit separation of the bulbs and soil. An attempt has been made to facilitate the use of the potato digger by planting shallow so that the bulbs are covered only by 1 or 2 inches of soil and then banking 4 or 5 inches of soil over the row. This plan is dangerous. It is fatal in the North, where the danger of freezing injury is too great. With Paperwhites in the South the bulbs split up too much. It is more than probable that even in the South the polyanthus growers will eventually plant not less than 5 or 6 inches deep.

One or two complicated and powerful machines have already been built which will dig a double row, separate the bulbs, and elevate them into sacks. A soil free from clods and rocks is obviously necessary for their successful operation. Thus far these machines have been rather rough on the bulbs. Paperwhites have been dug by these contrivances, however, without injury. Machines have now been perfected for successful employment in large operations with Dutch stocks as well.

Hand labor is considered unnecessary in digging daffodils planted in rows. They can be plowed out with so much less effort than hand digging takes and with even less injury to the bulbs.

Digging in the garden planting should always be done with a spading fork, a short-handled spade, or even a trowel, in various ways, the main consideration always being the protection of the bulbs from being bruised.

The time of digging is important, but it is a very difficult matter to say when it should be done. An experienced grower when asked by a novice when to dig his daffodils replied: "Dig before you think they are ready to dig." It was good advice in this particular case, but not very enlightening.

Digging can usually take place before the tops are completely dead. Indeed, they need seldom be over two-thirds dead before being lifted. In the Pacific Northwest it is not practicable to wait even this long on the poeticus and some of the poetaz varieties. They are commonly, if not usually, dug with the tops quite green. Indeed, the poets in moist soils will be found making new roots before the old leaves die.

In the resetting of border and other semipermanent plantings it is generally necessary to lift the bulbs before the tops have disappeared, in order to be able to locate the clumps. This can be done safely without serious injury or, indeed, any noticeable detriment from the time they begin to turn yellow. If dug much too early there will simply be a decrease in the size of the bulb, which will not be a serious matter in noncommercial handlings.

The commercial grower of bulbs digs every year. This seems to be necessary in order that the stocks may be properly sized and spaced to produce market qualities. Sometimes when sales are not expected the following year, lots may be left undug for two years, but not longer.

In the production of cut flowers and in garden plantings generally, on the other hand, digging will not take place oftener than once in two years, often only once in four or more, but preferably it is thought every third or fourth year. The best results in flowering take place usually the second and third years. Of course, allowances are or should be made in spacing at planting time if bulbs are to remain undug for two or three years.

## CHANGES IN BULBS DURING STORAGE

When daffodil bulbs are first dug from heavy soil they are often dark in color. As they dry for a few hours to a day or two the brown to tawny coats become slightly exposed. When the bulbs are shaken in the shakers preparatory to being removed to the bulb house, a great many of the old blackened coats are abraded off, and the bulbs become much lighter in color. When placed on the shelves, therefore, they are much brighter in appearance, but the roots are commonly still green, and the snouts, which in many varieties are likely to be more or less putrid from the sloughing off of the old leaf bases, have not completely dried up.

When the bulbs are dug, the propagation in the form of slabs on the sides of the mother bulbs may be close and quite firmly attached. Many or all of them loosen and spread apart as the bulbs dry, so that three or four weeks later most of the fresher coats are exposed. This exposure and the drying of the coats themselves, together with the abrading of the blackened remains of the old outer covering, cause

the bulbs to present their true marketable appearance in various shades of light brown or tawny so characteristic of these stocks. The real shade of color varies greatly with the variety, the nature of the soil in which the bulbs are grown, and somewhat with the method of handling, especially with the length of time they remain in the soil after maturity.

The customary way to test the quality of a consignment of daffodil bulbs is to cut open a few in order to determine the presence or absence of a flower, which can usually be plainly seen at planting time. This is the test of the novice, however, rather than that of the experienced bulb grower. The latter knows quite accurately when a variety has reached the size to flower, and he also knows that a bulb will flower when it reaches that size. The experienced grower knows without sacrificing any bulbs whether they have flowers in them. The only point for which he needs to examine the inside of the bulb is to determine whether the flower has been killed by bad treatment. This can be determined only by dissection.

The fact is that a daffodil bulb which has been well grown has a flower in it when it has reached flowering size as certainly as a normally developed pea pod has peas in it.

At the time of digging, however, unless the digging is long delayed, it is not usually possible to see the flower. It develops within a few weeks, the length of time depending upon the temperatures in storage, and by the last of August it may be half an inch or more long. If the bulbs are held at low temperatures, the flower may not develop much for two or three months.

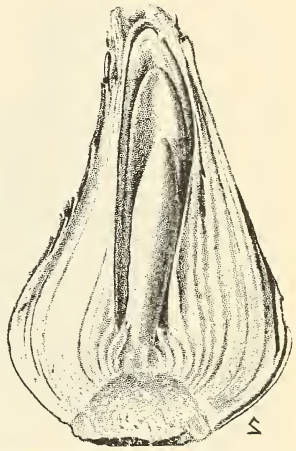

FIGURE 18.—A daffodil bulb (Emperor) cut vertically, showing the flower spike far advanced late in the season

It must not be considered, therefore, that the bulbs are really dormant on the shelves. Profound changes are taking place all the time, not only a drying out, which enables them to be packed and shipped, but life processes are taking place which are just as complicated and fully as interesting as those occurring during growth in the field and with no external evidence.

The development of the flower spike begins to be visible a few weeks after the bulbs are dug and should continue without interruption until flowering time. The later the planting, the farther the bud is developed. (Fig. 18.) However, if planting is prolonged much beyond the first of the year in most varieties, or if the bulbs are subjected to certain abuses either in storage or in transit, the buds will be killed. Probably the most frequent causes are high heat and self-generated heat in mass anywhere along the line up to planting.

## SEPARATING AND CULLING

As described on page 9, the daffodil bulb persists indefinitely, the reproduction being by a splitting process in which the old bulb divides into segments of variable relative sizes. The daughter bulbs

or splits, gradually separate until the cleavage of the basal plate is complete and independent bulbs are formed. When bulbs are dug annually these separations are not perfected by the ordinary processes of growth. It becomes necessary to make the separations artificially by breaking the daughter bulbs apart, thus rupturing to a greater or less extent the remaining portion of the basal plate.

Just how much of this separation of daughter bulbs should be performed is a decision that can be arrived at most satisfactorily only by experience. Some of the separation must take place with all stocks each time the bulbs are dug. In a general way, it can be said that the separation should not be carried out so far as to rupture the basal plate too much. Only those divisions of the bulb clump should be pulled apart which are far enough separated naturally so that they break readily without too much wounding of the base.

FIGURE 19.—Victoria bulb divided too much. The base of the slab is pulled out and is seen attached to the mother bulb

Some varieties are much harder to get apart than others. Slabs round off and are more easily separated if grown to the right point of development before being dug. Such forms as Autocrat, for example, round off and make the basal separation much quicker than Sir Watkin, which is difficult to handle in this respect. Stocks have been seen which were nearly ruined by having the separation carried too far. It would be better to plant clumps and let them come apart naturally than to carry this breaking process to excess. Bicolor Victoria is another variety which is likely to be injured by careless removal of the slabs.

In Victoria, and also in Sir Watkin, the slabs may sometimes be well spread from the bulbs and still be attached so firmly by the bases that the plate of the slab actually pulls away from the scales and leaves the slab without a base. (Fig. 19.) As a result of this kind of careless breaking in these varieties the flat slabs rot the next year, but as they rot small bulblets are commonly formed in their angles. These are so small that it takes three or more years for them to flower. The only way to avoid injuries of this kind is to use care in the breaking of the stocks or to plant the tight slabs without separating them.

Some growers use a knife and actually cut the bases in Sir Watkin. This is very laborious and is believed to be injurious to the stocks. It is better to plant tight clumps and wait for nature to make the separation, which will take place without a wound and with no injury to the bulbs.

The operation of breaking the bulbs apart takes place at the time of cleaning. Really, the whole thing is one operation, the conventional procedure being the removal of the bulbs from the shelves

or trays to a large railed table. Men or women work around this table and perform the operations according to various plans. (Fig. 20.)

A good way is to have the workers pick out one size of bulb, usually the double-nosed or largest size in the lot, and put them in containers to be returned to the shelves, to crates, or elsewhere, the remainder of the stocks being allowed to accumulate on the table and finally being shoveled up and taken to a sizing or cleaning machine.

In commercial culture the amount of breaking apart of bulb clumps should be rather limited. It is confined mostly to the double-nosed bulbs and clumps planted, for the other sizes will have little or no propagation to be taken off. This point will be better appreciated after a consideration of the subject of propagation, on page 9.

At this time, while the bulbs are on the table before the workers in plain view, there is an excellent opportunity for culling the stocks. Any imperfect, partly decayed, soft, light, injured, or cut bulbs should be thrown out. A very large percentage of bulbs harboring the narcissus bulb fly can be detected at this time and eliminated.

FIGURE 20.—Cleaning, breaking, culling, and separating large bulbs by hand

If common stocks are being dealt with, it is best to destroy the culls. On the other hand, the expensive sorts should be gone over by the most expert hands available and worked over, the rotted portions peeled off, and the bases trimmed to healthy tissue. Even if the bulb is perfectly white when finished it will recover and the smallest will blossom the third year. One of the finest small collections of Van Waveren's Giant on the Pacific coast to-day has been worked up from material which had few bulbs more than half an inch in diameter after being cleaned. It had a good sprinkling of blossoms the second year. All rejected material of this kind should be destroyed by burning, or otherwise, so that the fly and any other organisms it contains may be eliminated.

## SIZERS, SIZING, AND SIZES

The bulbs left on the tables at the time the bulb clumps are broken apart and the largest size removed may be shoveled into containers and taken to the sizing machines.

These machines are of various forms. The common nesting sieves with perforated bottoms are not suitable for handling large quantities of daffodil bulbs, even after the large bulbs are removed by hand. Foreign bulb growers employ a revolving drum having its walls perforated in sections for the egress of bulbs of different sizes

in each section, which is subtended by a chute which delivers them into suitably placed containers. This operates much like the well-known gravel sizer.

Rather satisfactory sizers may be manufactured very cheaply by the grower, but none are made commercially in this country as yet.

The machine used at the United States Bellingham Bulb Station consists of a series of parallel gratings (fig. 21), each grating consisting of a light wooden frame 24 inches wide and 16 inches long. The grating over the surface of these frames is made of half-inch half-oval iron bars fastened to and countersunk in the wood by means of countersunk screws. Each grating takes out one size of bulb.

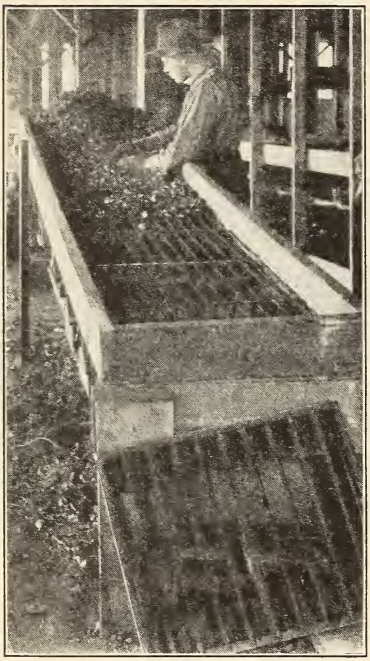

FIGURE 21.—A simple daffodil sizer made of a series of gratings of parallel bars

In the particular machine in question the distance between the bars in the different gratings is equal to the diameter of bulbs of 6, 8, 10, 12, 14, and 16 centimeters in circumference, respectively. The machine is therefore capable of making seven sizes, since bulbs above 16 centimeters go over the last grating. It is seldom that all the gratings are used.

The gratings are placed end to end in a frame constructed of 2 by 6 inch lumber and set about 2 feet higher at one end than at the other. They therefore form the surface of an inclined plane about 14 feet in length. At the upper end the floor of the plane for about 3 feet is boarded solid. It is here that the bulbs are received. On the lower side of this inclined plane are fastened frames of thin pieces of lumber arranged to guide the bulbs passing through the different gratings into separate containers placed underneath.

The machine is most conveniently operated by three men. One brings and takes away the bulbs, while the other two stand on either side of the machine and pass the bulbs down the incline, first over one and then the next grating, working preferably with gloved hands.

The largest amount of work occurs over the first grating, for all bulbs less than 6 centimeters in circumference and all the dirt and débris should be made to pass through it. The other sizes are therefore free from all débris and ready to go back on the shelves, into crates, or into the field if planting is in progress.

The contents of the receptacles under the first grating, in the case of the commoner varieties, will usually go to the dump after the grower has sufficient stock. If the contents are to be saved, they can be put through a grain fanning mill adapted a little for the purpose. The bars in the first grating could be placed closer so as to allow

fewer bulbs to pass through, or the bottom of the space at the top of the incline receiving the bulbs could be made of half-inch wire mesh to get rid of the débris before it reaches the gratings.

Attention should be called to the difference in performance between this form of sizer and one consisting of round perforations in a parchment or other thin plane. The grating measures the shortest diameter of the bulb, while the round hole measures the longest diameter in the case of somewhat flattened bulbs. Another difference is likely to be overlooked from the fact that in the use of the ordinary parchment sieves used for sizing tulips and described in a previous bulletin (*3*) the bulbs take the size of the sieve on which they are caught, while in the grating they take the size of the grating through which they pass. In order to make the two systems more nearly comparable it is necessary to step the grating system down 1 centimeter, or one size, in order to approximate the round perforation.

In practice the work of the sizer is very much reduced if proper sizing is done at each planting. The commercial grower must size closely before he plants, in order that he may know what he will be able to turn off at the next digging. It is not to be understood that all sizes in a variety grown in quantity are mixed as the sizing is done. It should be remembered that the bulbs were sized the previous year. If brought into the bulb house as dug, they are partly sized already, on the different trays or shelves. When well sized and well grown, there may be such uniformity that it is scarcely necessary to size the smaller lots of the previous year's planting.

Sizing as a preparation for planting can not be too strongly emphasized. It is even more important in the culture of Paperwhites than in the culture of the Dutch stocks, because of the difference in the character of the marketable product.

It is very difficult to pick out with sufficient certainty from a mixed lot of Paperwhites the kind of bulb that the market wants. The more certain method is to size rather carefully before planting, when the splits are more easily judged than are the merchantable stocks. The taking out of bulbs for the market then becomes very much simplified, because the whole progeny is from bulbs as nearly alike at planting as the sizers can make them.

The number of sizes that should be made is, after all, very flexible, but it is believed that in the Paperwhite there should be segregated no less than two sizes of splits, one or possibly two sizes of round, and the mother bulbs, in which numerous divisions are already outlined.

The case is quite different in the Dutch stocks, but sizing is just as important here, for it is only when there is a record of the different sizes planted that an accurate estimate can be made of the quantity that may be marketed at the next digging.

Besides this, it is only with good sizing that the grower can make a proper and equable distribution of planting material on the land, whether in beds or rows.

## HANDLING IN STORAGE

The daffodil crop is a bulky and heavy one, consequently economy of space and handling must be the watchword in order to make it pay. A crop may measure anywhere from 300 to 1,000 loose bushels to the acre. It costs money each time the bulbs are transferred from one situation to another. The effort must be to give the stocks the conditions that they need with as little labor as possible.

As has been pointed out, it is possible at times in a cool region like the Pacific Northwest to leave the bulbs in windrows in the field to effect a measure of drying if the sun is overcast. It is possible, if the weather is favorable, to make a separation of the bulbs in the field. The large or merchantable bulbs may be taken out and put in well-aerated, slatted crates ready for market. These crates should be piled up in an open shed where there is a free circulation of air and where the bulbs will continue to give up moisture.

Such handling is not practicable in hot regions, nor where there is a summer rainfall. It would be fatal in much of the Atlantic coastal plain. It could not be practiced even with such a resistant variety as the Paperwhite, which is much less easily injured than the Dutch daffodils.

The smaller bulbs left after the above separation, or all the stock if the separation is not made in the field, are taken to the bulb storage house and put on shelves, benches, or trays, in layers thin enough to permit the drying to continue and to prevent any possibility of sweating or heating. It may be possible to overdry daffodil bulbs, but there are not many situations where this is at all a problem. The common danger is that they heat, mold, or sweat, and are not sufficiently aerated.

The bulbs can be transported from the field to the storage house in any suitable container. A rectangular lug box holding 1 bushel makes a very convenient vessel and packs advantageously into the wagon box or truck body. In the Netherlands willow baskets of larger capacity are employed. Galvanized-iron bushel tubs are reasonably satisfactory also. Baskets or boxes have the advantage of being well aerated and are less likely to bruise the bulbs.

The bulbs, freshly dug or partly dried in the windrows, are likely to have considerable soil clinging to them. This is true in heavy soils as well as in some types of sandy loams. It is desirable not to take this soil into the storage house nor to place it in the crates when separation of the bulbs takes place in the field.

The machine employed to remove the soil from the bulbs after digging is commonly called a "shaker." It may consist of a rectangular box 28 inches wide, 6 feet long, and 8 inches deep, having a bottom of half-inch wire mesh. (Fig. 22.) The box has a handle at one end, and the wire screen terminates a foot from the other end. Over this opening is fastened a sack from which the bottom has been removed. Through this sack the bulbs when cleaned are dropped to the lug boxes automatically by a motion slightly different from that used in cleaning the bulbs. The box screen container is hung in a stout frame so that it can swing backward and forward with

a sort of jerking motion which slides the bulbs from one end to the other. The removal of a movable partition in one end, and a slightly modified shake, drop the bulbs into the lug box on the ground without handling. When daffodil bulbs are fairly dry, about a dozen oscillations of the bulbs from one end of the screen to the other are sufficient to remove the loose soil from a load consisting of about a bushel of bulbs. Then with four more jerks of the handle the sieved bulbs are dropped into the lug box.

A modified form of this shaker consists of the screen-bottom box pivoted on a piece of pipe supported on two stakes driven into the ground. The box is then oscillated through a small arc, allowing the bulbs to slide from one end to the other; thus the soil is screened out.

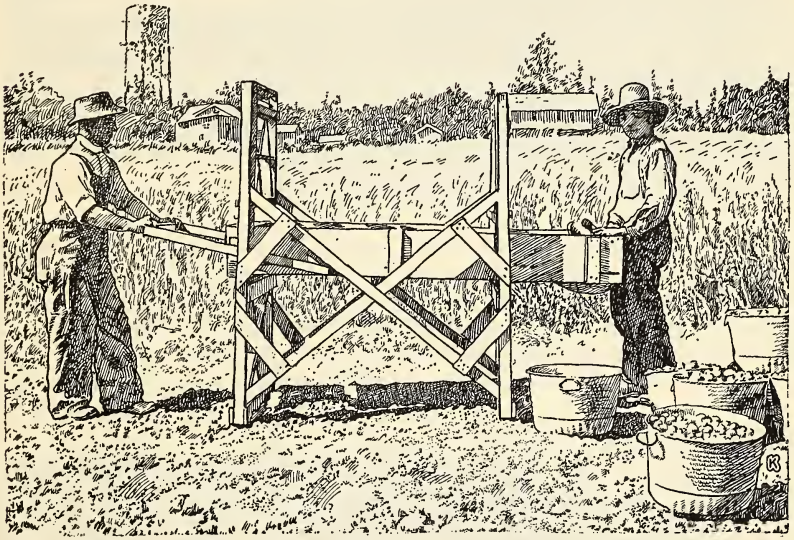

FIGURE 22.—Shaker used to remove soil from daffodil bulbs before they are removed to the storehouse

When the bulb containers arrive at the storage house they should be emptied without undue delay, especially in warm weather, and the bulbs spread thinly where there is a free circulation of air. Any "stuffiness" should be avoided, and the temperature should be as much lower as practicable than that outside.

No set plan for the construction of the daffodil storage house is necessary. Many types of suitable structures are possible. Usually an open shed (fig. 23) with eaves projecting far enough to keep off sun and rain makes the best place to store the bulbs. Foreign growers put up temporary racks supporting four or five shelves 3 or 4 feet wide in the field. These storage places may be covered with corrugated iron or other roofing to keep off sun and rain.

If the storage takes place in a building walled up all around, it is imperative that ample provision be made for thorough ventilation in all portions of the storage area. (Fig. 24.) Damp and

stuffy corners must be avoided. The ordinary window does not always furnish suitable ventilation. So-called French windows extending from the floor nearly or quite up to the top of the storage area, arranged to swing wide open and occupying one-third to one-half of the walls on both sides, are much to be preferred. If these are arranged opposite each other, thorough and frequent change of air may be effected.

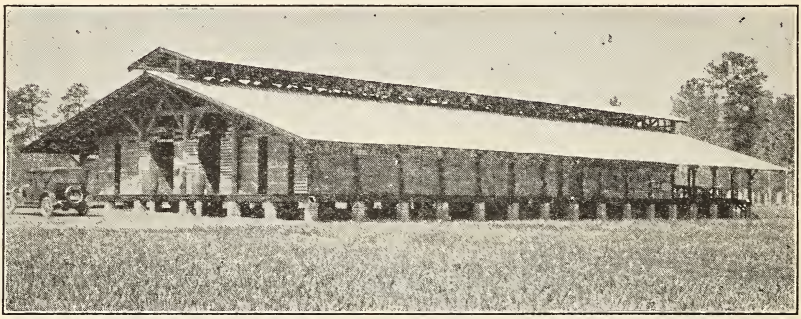

FIGURE 23.—A storage shed for Paperwhite narcissus bulbs on the Buckfield Plantation, Yemassee, S. C.

The interior arrangement of the daffodil storage house may also be endlessly varied. The most approved arrangement is the one having permanent racks built for the reception of trays which slip in on supports placed 9 or more inches apart. (Fig. 25.) The trays may be of various forms and sizes, depending upon how they are to be used. A tray 18 by 30 inches will hold nearly a bushel of bulbs and can be handled by one man. One 4 by 4 feet will hold 2 to 3 bushels, and requires two men to handle it.

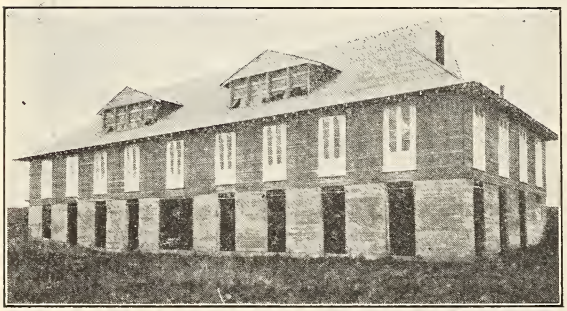

FIGURE 24.—Bulb house in construction at the Bellingham Bulb Station, showing provision for ventilation

The most economical use of tray storage is without racks, the trays being stacked crisscross, straight with removable 2-inch blocks between, or straight with the blocks built in on the corners. It is possible to take such trays into the field to be loaded and then to stack them in the storage space without further disturbance of the bulbs.

The trays are simply shallow boxes. They may have solid bottoms, but most growers make the bottoms of lath, in order to insure better aeration. The spaces between the laths should be very narrow, to preclude the possibility of the smallest bulbs passing through and thus mixing the stocks. Some growers prefer to have tight bottoms in their trays, and such are to be preferred if they are to be used also for miscellaneous stocks, on account of the great danger of mixing.

The trays may be 2 to 6 inches deep, depending on how they are to be used. There is no standard size. One grower built his trays 3 by 9 feet (fig. 26), which is rather large. Another grower uses trays 30 by 48 inches with bottoms of lath. The sides are 5 inches deep and the ends 4 inches. These are piled crosswise as high as convenient. Each tray holds 2 bushels, and when the trays are stacked in this manner all contents may be inspected.

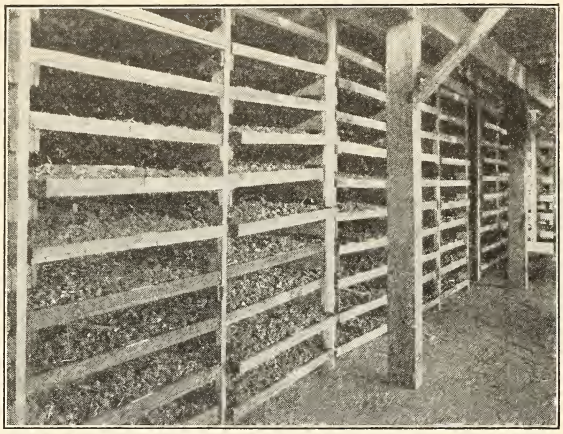

FIGURE 25.—Bulb trays in position in their racks. Bellingham Bulb Station

The bulb-storage space may also be fitted up with solid benches in tiers one above another, as high as the grower wishes to carry the bulbs. The shelves should be solid and may be 10 to 24 inches apart, the spacing depending on how the bulbs are to be handled on them. If it is intended to dump bulbs from lug boxes directly to the shelves, the 24-inch space is necessary. If the shelves are placed closer than this, they must be loaded with bulbs by means of a scoop which receives the bulbs from the lug boxes. (Fig. 27.)

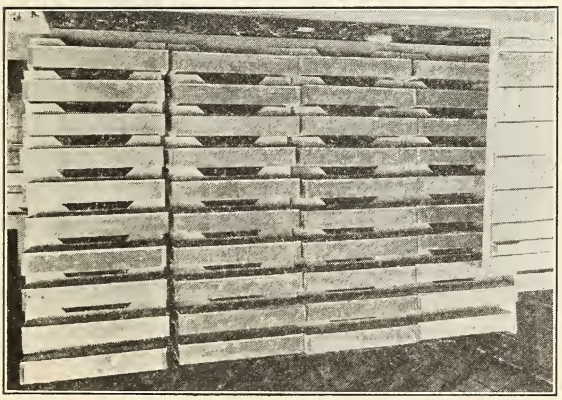

FIGURE 26.—Bulb trays constructed with 2-inch blocks under corners. These measure 3 by 9 feet

The shelves need a 2 to 4 inch strip along the edges. They may be 5 feet wide if approached from either side and may or may not be divided by a partition lengthwise through the middle.

The alleyways between successive tiers of shelves will also vary according to the grower's ideas or ability to provide convenience. There must be room enough for handling the scoop and lug boxes and enough space to go through with a small truck cart, or a barrow may be provided. The shelving should be planned so as not to obstruct the freest possible circulation of air.

After the bulbs are on the shelves they need not be disturbed again until they are worked over for separation into sizes. How

long they need to dry before this is done will depend on the condition of the bulbs when dug and the suitability of the storage space for drying. At the Bellingham Bulb Station two weeks is considered a short enough time for the bulbs to dry on the shelves before being worked over preparatory to sale or replanting.

## MERCHANTABLE STOCKS

The market demands for different types of narcissus stocks are very diverse. Different categories are required in the different groups. The requirements are not uniform in all countries.

FIGURE 27.—A scoop used to facilitate handling bulbs

In the Dutch daffodils the bulbs acceptable to the market may be designated as double-nosed, round (or single-nosed), and first and second sizes. Often the double-nosed bulbs are sold in two sizes. All these categories are employed in forcing and bedding. Another designation is mother bulb, which is the clump as dug and which may have two, three, four, or more noses.

The market has been accustomed to very large, loose clumps, with two to four or more splits firmly attached by their bases, in the Chinese sacred-lily imported from the Amoy region of China. There has been an effort in the United States to substitute a round bulb comparable to that of the Paperwhite. The production, however, has not been extensive enough to warrant a prediction as to what will be finally adopted as the standard market quality.

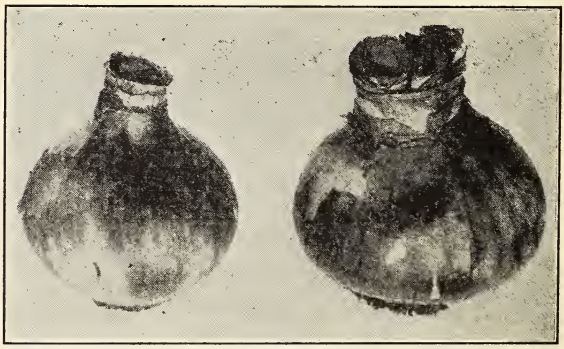

FIGURE 28.—Two round bulbs of Paperwhite. The one on the left will give good results, but the other, although larger, will give too much "grass"

The requirement in the case of the Paperwhite is definite and represents a small arc in the cycle of the development of the bulb. (Fig. 28.) In this case the merchantable article consists of a firm, round, tight, single-nosed bulb measuring from 11 centimeters upward. The common sizes are 13, 14, and 15 centimeters in circumference. Grand Soleil d'Or, Double Roman, and some other but not all polyanthus varieties are gauged by the same standards.

There is no question that the Paperwhite standard is the best bulb that can be secured of the variety. It throws one heavy spike of blossoms and only one, while a split bulb may throw one or more small ones, or none, and is therefore undesirable to the consumer. In the Dutch stocks, on the other hand, the double-nosed bulbs may give an average of 1½ flowers, seldom more. The single-nosed or round bulb of the Dutch stocks gives one good flower, and the flowers will be uniform if the bulbs are well sized.

There are those who maintain that, all things considered, the round bulb of the Dutch varieties, as well as the Paperwhite, is the most advantageous to the forcer, because the flowering is more uniform and the bulbs occupy less space in the flats. It is certainly easier to estimate the flower cut from the single than from the double-nosed bulbs. They can be sold at a cheaper price and do not represent such a drain on the grower's capital stock. While increasing stock it is almost necessary for the grower to sell round bulbs only, unless he supplements his efforts by comparatively large purchases of planting materials. The writer is inclined to the view that there may be decided advantages at present in the much wider use of round bulbs. It involves a more certain performance in a more standard product, which transaction contains no injustice to the consumer but enables the grower to work up stocks much more satisfactorily. There has been a recent tendency among some growers to conserve their stocks of Dutch daffodils by emphasizing the sale of round bulbs. The increase of stocks in the Paperwhite is facilitated very much by the fact that the market requires a round bulb rather than one with two or more noses. However, reproduction in the Paperwhite is so much more rapid that there is little difficulty in increasing one's holdings.

## PACKING AND SHIPPING BULBS

Daffodil bulbs should be well dried before being placed in containers for shipment. No preparation other than drying is necessary, but this should be carefully attended to, else there may be sweating, rooting, and heating in the pack. This is always accompanied by the development of various organisms of decay.

Being a bulky crop, the daffodil is almost invariably packed and shipped in large masses in slatted crates holding 4 to 8 bushels or more. The construction of the crates is such as to insure the freest possible circulation of air about them when piled in large numbers. The battens are on the outside of the slats so that there is an inch or two for air circulation between the crates even when piled as closely as possible.

The construction of the crates at present employed by the Bureau of Plant Industry is shown in Figure 29. They hold about 8 bushels. The crates used by European shippers are of identical construction, but are of varied sizes to accommodate different quantities, different-sized consignments, and different characters of bulbs. Smaller shipments are adjusted by partitions put through the large crates, or at times the conventional perforated paper bulb bag is employed for individual lots. It is thought that these 8-bushel crates are rather

too large to handle well and that a flat crate would insure better aeration.

Packing materials are seldom employed nor are they necessary in shipping daffodil bulbs. If the bulbs are well dried before being packed and if the pack is well aerated, there is little occasion to use chaff, peat, or any other material between the bulbs.

## FORCING

By "forcing" is meant the act or art of producing flowers out of season. Commonly forcing is associated with a higher degree of heat than usual. In the forcing of daffodils, however, there is little real forcing or pushing along of the development with heat and humidity, such as is resorted to in the case of some lilies late in the season. Instead, the period of winter lethargy is reduced by keeping the bulbs under optimum or slightly higher degree of heat instead of under the low temperatures prevailing for a considerable period during the winter, under natural conditions.

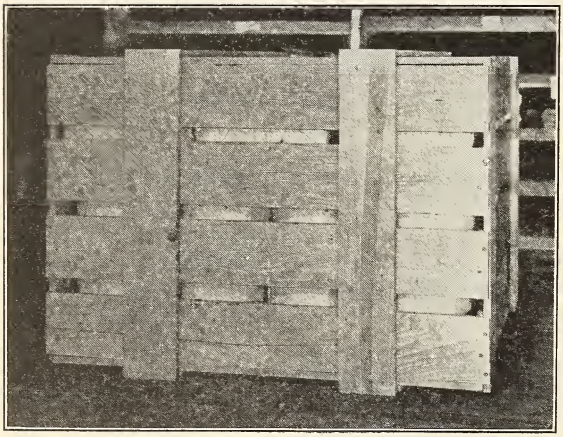

FIGURE 29.—A bulb crate

The best short rule, therefore, for forcing daffodils is, Do not force them. Let them come along slowly without attempting to push them into rapid development by increasing the heat. In any forcing of these bulbs, if one keeps in mind an optimum of 50° F. for rooting, 50° to 55° for growth up to formation of buds, and 55° to 60° for the development of the bulbs, he can not go far wrong.

Of course there is no hard and fast rule for temperature requirement, for the temperatures may vary greatly from those given above. Success may be had with a rooting temperature as high as 60° F. Often in warm situations in the Atlantic coastal plain it is impracticable to get a lower temperature than 60° if the bulbs are potted early. Growing temperatures often run to 55° or more, and the day temperatures in the greenhouse in Virginia often can not be kept below 70°; yet success may be attained. It is, however, well recognized that conditions for rooting bulbs for early flowering are better farther north than at Washington, D. C., for instance. In other words, it is easier to bring some stocks into flower early at Rochester, N. Y., than at Washington, D. C., on account of the better rooting conditions in the former situation.

The commercial production of forced daffodil flowers for the cut-flower market requires experience and skill. The professional grower has preparations for the task going on the whole year.

The soil pile is one of the important factors in success. It takes not less than 12 months to prepare good soil for forcing daffodils. This is put up in alternate layers of good sod, cow manure, and sand, or the sand may be incorporated at planting time. This is put up in the form of a butte and turned three times in 12 months.

The systematic operator keeps an area in turf from which sod to a depth of 6 inches is removed annually, the used soil being returned to the field and reseeded for use two or three years later.

While this is the best and most approved method, millions of daffodils in these days of high labor cost are forced with commercial success and profit in ordinary field soil entirely uncomposted. Some fertility is usually added in the form of bone meal, pulverized sheep manure, or other commercial fertilizers at the time of potting. The flowers are not so good as they would be with better culture, but they are acceptable to the market, which is not very discerning as to fine quality.

The commercial grower plants daffodil bulbs mostly in flats or shallow wooden boxes about 24 inches long, 15 inches wide, and 4 inches deep. Drainage is provided for by spacing the bottom slats or by boring holes 3 or 4 inches apart.

Pots may also be used, but pans two-thirds the depth of pots are better. Neither are used as much as flats.

In planting, a layer of soil is placed in the flat, and the bulbs are set often as thickly as possible in commercial practice. Three to six bulbs are set to a 6-inch pot. Bits of sod, débris, or broken pieces of pots are put in the bottom of pots or pans to insure drainage. More soil is then put in to cover the bulbs and is firmed thoroughly by pressing down with the fingers of both hands around the bulbs.

The flats and pots are then thoroughly watered and put away to root in the heeling ground, as it is called. This situation may vary greatly. It is usually advised that it be a pit, a foot or so deep, with a layer of cinders in the bottom to keep earthworms out and insure drainage. In northern climates a pit is necessary, but in practice, especially south of Philadelphia, the flats or pans are mostly put on the surface of the ground. In any case, the whole is then covered with soil or often with straw, hay, or other débris and usually requires no further attention during the rooting period. Many growers do not even water the flats after planting. If rain is certain within two weeks this is even better, for the bulbs are less likely to decay if kept rather dry until roots start. If the season is dry, watering must be attended to, otherwise the stocks require no further attention for a while.

Instead of rooting the bulbs out of doors, some growers employ cellars or other buildings where the flats or pans are carried on shelves conveniently arranged. In such situations watering must receive careful attention. Satisfactory results may be had in such a situation, but unless one has had long experience it is better to depend on the more natural out-of-door condition where the stocks are completely covered with soil or débris so that they do not freeze. Moderate freezing, however, while not desirable, will not be disastrous.

The time for setting the bulbs will vary greatly from August 1 to January 1. Normally, good results are not to be expected from late

plantings. If early flowers are desired, early August planting should be the rule, but normal performance is to be expected from plantings up to the middle of November or even December, provided the bulbs are properly stored.

If the Dutch daffodils are potted on August 1 they should be allowed three months to root. A shorter time at this season is not safe. This is short enough for the early varieties, but the late ones will take even longer. The grower should make certain that the flats and pots are well rooted before they are brought into the greenhouse. There is no use trying to flower daffodils until they have good root systems. An examination of a few pans may be quickly made by knocking out the ball of earth. Before they are ready to bring in there should be a mass of clean white roots occupying the entire bottom of the pan and extending well up along the sides. (Fig. 30.) The flats can not be thus examined, but the roots will be running out through the cracks in the flats into the soil in abundance before removal from the rooting ground should take place.

FIGURE 30.—A well-rooted pot of daffodils ready to be brought into the greenhouse

After rooting, the bulbs are brought into a mild heat, a moist situation, and subdued light. A favorite situation is under the benches in a house run at 50° to 55° F. at night. This will give a temperature of about 50° on the bulbs. During the day the temperature may run up to 60° or even 70° on the benches for a short while. This situation should be maintained until the buds show, which may take one to three weeks.

Unless the space under the benches is much darkened, the bulbs can next go on the benches in full light. It may be well to give them a temperature of 50° to 55° F. at night for a short time and then up to 60°.

With such treatment the earliest varieties, such as Golden Spur, Henry Irving, Ard Righ, Obvallaris, Spurius (fig. 31), and Trumpet Maximus, may be brought into flower for Christmas. The majority of the varieties will be later, the late poeticus varieties, such as Recurvus (Pheasant's Eye) not blossoming until March or April.

It should be realized that the above statements as to the time required for the different stages of development are based on August 1 plantings of early varieties. The late varieties require more time, and later plantings require less.

A sharp distinction should be drawn between the handling of Dutch daffodils and of Paperwhite. Paperwhites will root in about half the time and are precocious in the production of top growth, so that they are not usually buried at all. From the latitude of Phila-

delphia southward, bulbs are grown which may be flowered for Thanksgiving in average years when placed under the benches at potting time and carried without heat up to the last few weeks. (Fig. 32.)

To recapitulate, the forcer of daffodils should always "make haste slowly." He should keep temperatures down, especially up to bud visibility, and after that 60° F. at night and 70° during the day with good ventilation is the limit, and 5 degrees lower in each case will give better flowers.

A decided measure of earliness may be effected by the use of glass-covered frames. Frames covered with fabric at night and on cold days are also very effective. Indeed, in many of our warmer daffodil climates, frame culture is about as effective as greenhouse culture.

The steam-heated frame is also well adapted to daffodil forcing in regions where the temperatures get low. Here heat may be even more satisfactorily used than on the benches of a greenhouse, for coolness of soil is assured.

One may plant the bulbs in flats or pots, as for greenhouse culture, but if they are to be flowered in the frames, space and labor may be saved by planting directly in the soil.

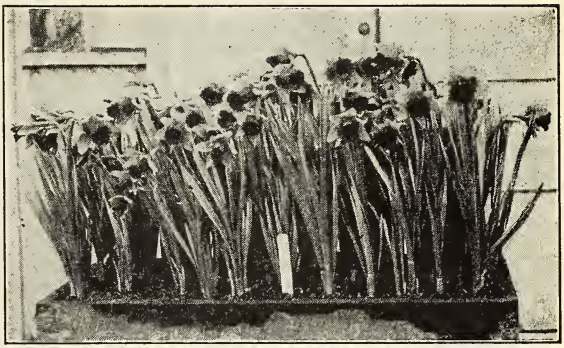

FIGURE 31.—*Narcissus spurius* from old naturalized stock after being cultivated three years

### FORCING IN THE HOME

The bringing of daffodils into flower out of season under dwelling-house conditions does not differ in principle or essential particulars from the production of flowers for the market. The same conditions should be met as nearly as practicable, but it is usually a little more difficult than under the controlled conditions of the greenhouse, although not presenting such obstacles as to preclude success by anyone who is willing to devote a little time and thought to the work.

As in greenhouse forcing, haste should be made slowly. The bulbs should be potted early in good porous loam through which the water passes readily with good drainage in the pots. Each step in the forcing, heeling, development of buds, and flowering should be prolonged until it seems that the plants can not be held back longer. This will insure success.

The main difficulties of forcing under dwelling-house conditions are high heat and aridity. American dwellings are both too hot and too dry for best results with daffodil bulbs. But by careful selection a situation can usually be found which suits the bulbs at all their seasons of development.

Escaping gas from either furnace or gas mains often acts deleteriously. Even the products of illuminating-gas combustion are

often detrimental when excessive in the atmosphere of the room. It should be emphasized that the best place for the development of roots is in the ground where the conditions are as natural as they can be even if the bulbs are incased in pots or pans.

FIGURE 32.—A normally good growth of domestic stock of Paperwhite narcissus

A cool, airy cellar, attic, or screened-in porch is suitable for the growth of the flower stem if the light can be subdued. The living room may be a little too warm to develop the flowers properly, but there is usually a situation near a window which is cooler and where

the conditions of temperature and light are fairly favorable. On the whole, a south or east window is to be preferred, but success may be had by a north window.

### FORCING IN OTHER MEDIA THAN EARTH

In the forcing of daffodils the novice will usually succeed in earth better than in any other medium. There are certain advantages, however, in the employment of other materials. There are conditions under which it may be difficult to get suitable earth, or the quarters may be so cramped that it is inadvisable on account of danger of injury to apartments and furniture to employ earth. At least, other substances are considered less objectionable by many.

Fortunately, enough food material for the production of the flower is stored up in the daffodil bulb the previous year. Consequently it is possible, by sacrificing the interests of the bulb, to draw on this reserve supply of food material for the production of a normal flower without the necessity of supplying the plant with any plant food as it grows. In such case the matrix in which the bulbs are planted supplies moisture and an anchorage, but little, if anything, more.

Very attractive decoration can be made by growing daffodils in coconut fiber, moss, or other fiber in bowls or other earthenware or glass vessels with no drainage. The method has the advantage of being clean, odorless, and free from the objectionable features of having soil in drained and porous pots in a living room.

A suitable number of bulbs are planted in the moistened fiber, much as one would plant in soil, except that a little more care is necessary to pack the fiber tightly around the bulbs to insure their remaining in position. The distances of the bulbs from each other should be about the same as when earth is employed.

After the planting it is well to fill the vessel with water and then invert it over the hand and let all the water that will drain out. The vessels are then set away in a cool, dark place. An airy cellar is very suitable, until the whole contents are bound together by the permeating roots. The planting must be watched to see that it does not dry out. As good a plan as any is to fill the vessels with water once every week or 10 days and drain as described above.

The subsequent handling after the bulbs are thoroughly rooted does not differ from that of bulbs planted in earth. Root formation must be copious before the plant is introduced into warmth; the temperature then should be 10° F. below the temperature of the living room, and the plant should preferably be shaded until the buds show. Then the cooler and lighter positions in the living room are suitable.

The fiber used for potting may be purchased ready to use from seed and bulb merchants, or the householder can easily prepare his own, remembering that the fiber is mainly a matrix and does not necessarily furnish anything but an anchorage for the roots.

Coconut fiber or sphagnum moss can usually be purchased readily. In most places the householder can gather his own moss from the woods. If it has considerable admixture of débris, that will not matter. This may be all the more attractive, as it will be green and

much of it may live. When potting, it is well to place a few small pieces of charcoal in the bottom or to mix them with the fiber used. It is also usually advisable to incorporate with the fiber a little pulverized oyster shell or bits of marble or limestone, but the lime is not so essential with daffodils as with some other bulbs.

Attractive plantings may also be made by substituting pebbles or coarse sand for the fiber. When this is done, care should be taken to keep the water level in the bowl barely up to the base of the bulb. Merchants now supply varicolored pebbles of porcelain or glass for this purpose. Some of the combinations of colors are very attractive in themselves. Charcoal is especially desirable here also.

Granular, thoroughly washed anthracite coal may be employed in the same way as pebbles for growing daffodils indoors. One may also plant them in sponges. Those who have conservatories or any room approaching the conditions of one can flower daffodils in hanging baskets in moss, or in other fibrous materials that hold moisture well. The householder will be able to devise other means best suited to his local conditions and equipment.

### DAFFODILS IN HYACINTH VASES

Some daffodils are just as well adapted as hyacinths to be grown singly in vases of water; that is, they grow just as well, although on account of their height and smaller mass of flowers they may not be quite so attractive from some points of view. Interesting cultures may be made in this way, though, and the method commends itself to many. It may be employed to add a pleasing variation from the more conventional types of culture in the household. (Figs. 33 and 34.)

When putting the bulbs away to root (one can call it planting if he chooses), the water in the vase should barely touch the base of the bulb, otherwise rot is likely to set in. Indeed, if the bulb fits tightly in the neck of the vase, rooting will take place readily if there is an appreciable space between its base and the surface of the water.

The conditions for rooting, budding, and flowering should be no different from culture in pots. The only requirement not previously enumerated pertains to changing the water once a week. It is also advisable to keep a lump or two of charcoal in the vases.

The first and foremost daffodil for any form of dwelling-house culture is Paperwhite. The Chinese sacred-lily is an important one under many conditions but not suited at all to the steam-heated apartment, although it does beautifully in the Chinese laundry window close by. Grand Soleil d'Or, of which much is to be heard when American stocks have become more plentiful, should be mentioned in the same connection. Next to these, but blooming somewhat later, should be mentioned some of the Dutch polyanthus varieties such as White Pearl, Grand Monarch, Mont Cenis, and Gloriosa.

The older trumpet daffodils do well under house culture. Such varieties as Spurius, Double Van Sion, Trumpet Major, Golden Spur, Obvallaris, Princeps, and Henry Irving all do well, although Henry Irving and Obvallaris may be hard to get, for they are seldom grown to-day and there are no stocks of them in the United States. Sir Watkin, King Alfred, Tresserve, Victoria, Spring Glory, Glory of

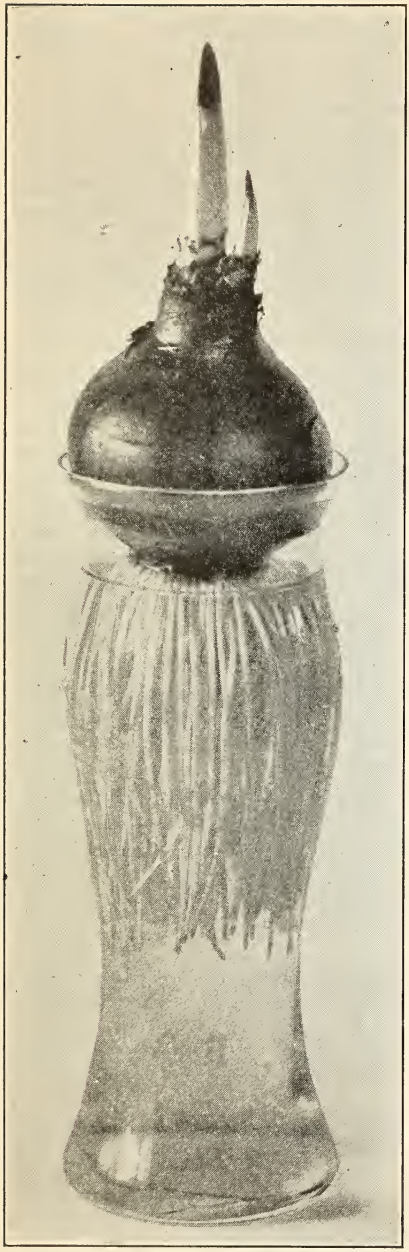

FIGURE 33.—A normal bulb of Paperwhite grown in water in a hyacinth vase, showing root growth some time before the householder should attempt to bring it into light and heat

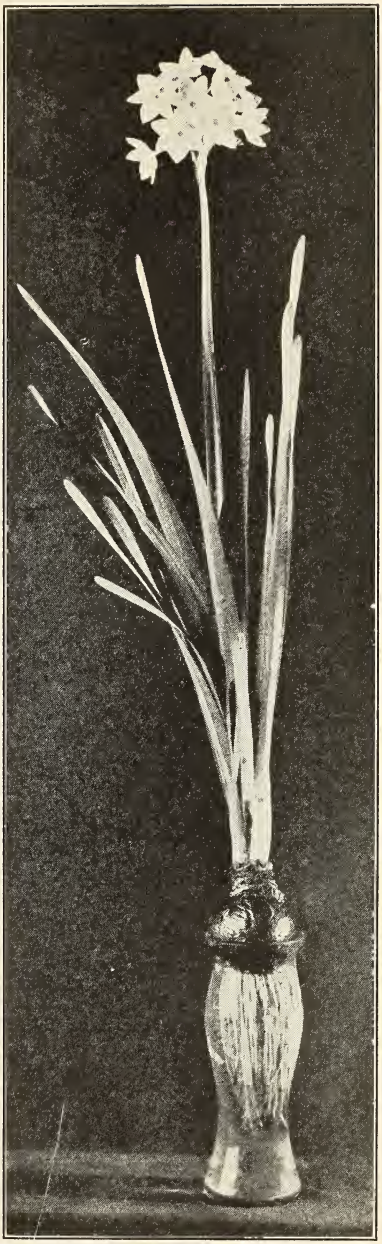

FIGURE 34.—The bulb shown in Figure 33 in full flower. Note that the roots have grown but little since that photograph was taken

Sassenheim, Gloria Mundi, Madame de Graaff, M. M. de Graaff, Van Waveren's Giant, Emperor, Conspicuus, Madame Plemp, Vanilla, and Ornatus come a little later but are just as certain.

### SHORTENING THE FORCING PERIOD

Daffodil flowers are usually much more valuable early in the season than later. The goal striven for has been daffodil blossoms for Christmas. This has sometimes been attained in a small way, but seldom satisfactorily. In order for the accomplishment to be remunerative, of course, a volume is necessary, and such volume must be dependable. But the flowers for Christmas have seldom been satisfactory.

Various schemes have been resorted to for obtaining early flowers. The Dutch growers formerly sent early varieties such as Golden Spur and Victoria to southern France for one year in order to acquire earliness. France grew regularly the early variety Trumpet Major adapted to warm regions. Acquiring earliness in these ways is precisely what is now being accomplished by producing the bulbs in the tidewater regions of Maryland, Virginia, and the Carolinas.

Daffodil bulbs stored at ordinary temperatures up to August 1 and then at 50° F. to potting September 1 will be accelerated 3 or 4 weeks. A greater acceleration will result from earlier subjection to 50° or to a lower temperature, but intolerable dwarfing is likely to occur.

Untreated daffodil bulbs potted September 1 take 4 to 5 months to flower. If good bulbs are held at root cellar temperature (or at constant 50°) until January 1 to March 1 they can be flowered in 4 to 6 weeks. Early potting necessitates 8 and preferably 10 to 12 weeks in cool temperature (50° F.) for rooting, but when potted after January 1 they may go directly into a 60° temperature and be kept there to flowering. The later the potting, provided storage is cool, the shorter the flowering period. Late in the season early and late forcing varieties tend to blossom close together.

### SALVAGING FORCED BULBS

In a previous publication (*4*) it was considered necessary to offer arguments for the preservation and further use of forced and bedding bulbs. No arguments are necessary to-day, for the advantage is well recognized, and the salvaging of the bulbs is largely practiced. All that is necessary now is to consider the methods employed in saving such stocks.

The normal thing is to leave these bulbs undisturbed after flowering until the tops die down naturally. This time, for stocks grown out of doors, will vary from late May to mid-July, depending upon the season and the locality. When premature digging or removal of the foliage occurs, as in forced stocks, the natural development of the bulb is interfered with. The endeavor should be to handle the bulbs in a way as nearly natural as possible. There is, however, much latitude in the possible methods of handling.

Bedding daffodils, removed from the beds as the flowers fade, have been dug in the experimental work of the Bureau of Plant Industry with the tops on. Some have been heeled in on sandy soil in the field,

some in sand on the north side of a building, some stored in crates to dry in a root cellar, and some under the shade of trees with only the foliage covering the bulbs. This work, however, has not been done with counts and measures in a manner careful enough to enable one to point out definitely the extent of superiority of one method over another. All that can be said is that all of these methods of handling have produced bulbs that flowered the next year with a bulb production of first quality, but doubtless with a reduced size of bulb and with only a slight reduction in the size of the flower. In these handlings, as in the case of normally grown field stocks, the bulbs have been taken up and stored on shelves as soon as the tops were dry. The drying requires only two or three weeks in the climate of Washington, D. C.

Forced bulbs available as propagating stock for the grower are usually in flats of 2 to 4 dozen each. It is the common practice to cut the plants off at the surface of the flats. This is strictly true in tulips. In daffodils there are usually some leaves left on the plants, and always half of them at least are not used in decoration with the flowers. As it is desirable to preserve and protect the flats as much as possible, the contents can be dumped out in a shed or in a shady place under trees, if the weather permits, to dry out and mature slowly. The length of time this will take will depend upon weather conditions. Four to eight weeks will usually be sufficient to put the bulbs in condition to be taken out and put on shelves. If all the leafage has been cut off, the matted flat contents can be piled up two to four or more deep with little or no disadvantage.

The method of caring for the bulbs up to the time of planting will depend again upon the locality and the atmospheric conditions. It should be noted that these forced and bedding bulbs are coming out of the ground earlier than normal stocks by four to six weeks. This means that they are going to dry out for that additional length of time before the planting season arrives. In the cool, damp climate of Puget Sound that may not be a serious factor, but in the Atlantic coastal plain, where the temperatures run high during the season from June to September, the bulbs will need protection from excessive desiccation. They are best kept in cool cellars or half cellars, and for best results they may need covering with dry sand, grain chaff, or burlap, to prevent excessive drying. The handling need not be different from that of normal stock.

A very striking example of the ease with which the use of forced stock may be effected is familiar to growers on Puget Sound. One florist habitually for years knocked out the matted contents of the flats into beds the width of two flats placed end to end. A little soil was sometimes thrown over the bulbs after they died down. Even bulbs handled in this careless way grew, multiplied, and gave a large cut of mediocre flowers for several years and then furnished a lot of planting stock.

Of course, the wisdom of saving the forced stocks will depend to a large extent on circumstances. It is when stocks are short or varieties are scarce that the greatest profit will result from the practice. When a grower has his production up as high as needed, it may not be economically profitable to handle such materials under field culture, but even then, if thin grassland or open woodland is available,

the utilization may be economically justifiable for the purpose of creating a reserve supply of planting stock of improved quality.

The point where it becomes economically unprofitable to save the forced materials is reached much sooner in the case of Paperwhites and Chinese sacred-lilies than in the Dutch stocks, primarily because of the more rapid reproduction in these varieties. The grower of these soon reaches a point where the problem is to keep his reproduction down to where he can handle it.

## RELATIVE USE OF VARIETIES

The varieties of the genus Narcissus that have been used by florists in the past are comparatively few in number. At the head of the list must be placed Paperwhite Grandiflora, which is almost invariably designated by the first name. Its importance results from its early forcing quality and ease of handling both in the field and under glass. The next in importance has been Golden Spur (fig. 35), which has a fine color and is very early for the self-yellow trumpet section. The earliest and best bicolor trumpet has been Victoria (fig. 36), supplemented later in the season by Horsfieldii and Empress.

FIGURE 35.—Golden Spur grown at Bellingham, Wash., and forced at Arlington Experiment Farm, Rosslyn, Va.

Double Van Sion has been used to a large extent and would be employed in larger quantities still if its form and color were more dependable. When normal, its color is good, and it flowers early. Princeps has been a popular trumpet mainly on account of its early forcing qualities. It is seen that the main characteristic of the varieties that have been used in large quanties in the past has been early forcing. Later varieties are also forced, but it is the early and solid colors that have been most in demand.

Other varieties used in quantities about equal to the latter have been Emperor, Conspicuus, Sir Watkin, Ornatus, Madame de Graaff, Trumpet Major, joss flower (Chinese sacred-lily), Double Roman, etc.

In recent years King Alfred, Glory of Sassenheim, Spring Glory, Tresserve, and Van Waveren's Giant have taken front rank in point of numbers in this country, while the French Soleil d'Or (the yellow Paperwhite) is probably destined to play a much more important part in the future of the forcing trade. Stocks of it are yet too limited for extensive use.

The future is fraught with great possibilities in the nature of the varieties to be employed. The promising varieties in moderate stocks are numerous. They seem to be destined to take the place of those now employed. It would be a bold prophet indeed who would attempt to predict at this time just which of the various stocks that are being worked up are destined to supplant present varieties. There is no question, however, that some of the newer creations are of very superior quality for commercial use.

## BREEDING DAFFODILS

In view of the long lists of excellent daffodils which have been evolved in foreign lands in recent years, it may seem presumptuous to assume that this country has anything to gain by engaging in

FIGURE 36.—Victoria grown at Bellingham and forced at Arlington farm

the venture of breeding. The accomplishments in the British Isles and the Netherlands have been little short of marvelous, and the work has been carried on in large measure as side lines, or as an avocation by men who were busy in other vocations.

Most has been accomplished in the breeding of daffodils in the British Isles and in the Netherlands. Nearly all of the leading Dutch growers start generations of new seedlings every year. It is in Great Britain, however, that the breeding of daffodils is reduced to an exact science with careful records and pedigrees covering activities of more than a quarter of a century. A fund of information along these lines is published from time to time in the Daffodil Yearbooks and the Journal of the Royal Horticultural Society, London, and the Annual Reports of the Midland Daffodil Society of Birmingham, England. These publications are replete

with information not only about breeding and new varieties exhibited but also about all phases of the daffodil business in both professional and amateur aspects, as well as much that is commercial.

Daffodil breeding is particularly characteristic of English-speaking peoples. Australia, Madagascar, and South Africa have their associations, their breeders, and their accomplishments. The United States can scarcely be said to have made a start as yet, although Kalifornia (Streator), Chief Seattle (Goodell), Peter Puget (Goodell), and Samuel Goodell (Goodell) are meritorious and to America's credit. The last three were actually named by John Van Aalst after Mr. Goodell gave up the work. Several other breeders are now busy, and it is to be expected that results will follow in due course. Byron Center, Mich., already has some good seedlings in the Barrii group. There have been some notable exhibitions of seedlings, particularly at Forest Grove, Oreg., in recent years. A healthy activity obtains in the vicinity of the District of Columbia. A demonstration of the possibilities has been made at the Bellingham Bulb Station.

There is one line of daffodil breeding that is almost entirely unoccupied and that is badly in need of investigation. The French growers have not undertaken the culture of Paperwhite as the Dutch have that of the hardy narcissus. The large commercial cultures of Paperwhite have not been backed up by new progenies of more virile and improved seedlings which are destined to take the place of the older stocks such as have obtained in the Netherlands.

The Paperwhite is a good variety in its way. It is easily grown, it blossoms early, and it is floriferous. However, in character of flower it leaves much to be desired. It also has a rather narrow range of marketability. The suitability of the bulb for forcing is confined to a round, single-nosed specimen, a range of size that is narrow.

The Paperwhite needs to have character put into its flower, and the fecundity of the bulbs needs to be improved so that the flowering quality of double-nosed or triple-nosed bulbs will be comparable with that of the same categories of Dutch stocks. Without a doubt this can be done. If even these two characteristics already existing in White Pearl were engrafted onto the Paperwhite without losing its early-flowering quality, what an improvement we would have!

This is a job for some one in our Southland to take up as an avocation. Some grower, some horticulturist, or some amateur may take it up as a side line to add zest and incentive to his more prosaic tasks. Such work must be done as a side line, for there is little likelihood of a monetary reward. But there is an opportunity for accomplishment, and there is the prospect of producing a Paperwhite flower with more character and a bulb that will give more flowers, even though it be split and unsymmetrical.

Another opportunity appealing to the writer is an attempt to breed trumpet daffodils better adapted to our warm regions, namely, the Atlantic coastal plain from New Jersey to northern Florida. It is a promising field and also a virgin field. Little or no attention has been given to breeding daffodils adapted to particular climates. Practically all of our varieties have come from Great Britain or the Netherlands. Troubles beset the growers of many

of the old-line varieties in our warmer regions. Who can predict what may be evolved by the use of pollen of jonquils, Campernelles, and their derivatives on King Alfred, Sir Francis Drake, Golden Frilled, and others of the hardier varieties?

A veteran daffodil breeder has advised: "Grow seedlings, pedigreed seedlings if you can, but grow seedlings." It is always better if the breeder has clearly in mind what he hopes to accomplish. His object should be to combine the desirable attributes that exist in the two parents into one. This can be done only by careful and controlled breeding. On the other hand, some of the best varieties we have to-day have resulted from promiscuous crossing or from open, naturally fertilized seed. However, the breeder who intends to stay with the job any length of time needs the best of parent stock and should keep a careful record of all his crosses. Even records of unsuccessful crosses and those yielding no useful progeny are likely to be very useful for future reference.

The operation of making the cross does not differ from the same operation in the hybridization of any other plant. The breeder must, of course, get familiar with the essential organs of the flower, especially the stamens, anthers, pollen, pistil, and stigma. The central organ of the flower is the pistil and its extremity is the stigma. On the outside of this and next to it are the stamens, the distal portions of which are denominated anthers, which contain the pollen.

The operator needs a pair of tweezers and a camel's-hair brush. Really nothing more is necessary, although a needle stuck into the end of a piece of wood, like a penholder, and a pair of small scissors may come in handy. A few watch crystals are very convenient for holding pollen, although pieces of paper are very satisfactory.

To actually effect a cross requires that the pollen produced by one plant be transferred to the stigma of the one that is to be used as the seed parent, the other being known as the pollen parent. It is presupposed that the operation is done in a cleanly manner and that all pollen except that applied has been excluded. To accomplish the latter it is imperative that the anthers be removed from the seed parent before they have opened and shed their pollen. This is usually done in the evening before the flowers to be operated on have opened. At the same time the flower is bagged to prevent visitation by insects which may carry pollen to the stigma from sources not desirable.

Pollination (applying pollen to the stigma) is done in the morning shortly after the flower opens naturally. This is usually 8 to 10 o'clock, after the stigma has secreted sufficiently to make its surface viscid. It is then said to be receptive, and the pollen is ready to use as soon as the anthers open.

The pollen desired is collected on a watch crystal or other receptacle and brushed on the stigma with the camel's-hair brush. The protective covering is again restored for two or three days. In order to insure perfect accuracy, it is also necessary to protect the flower of the pollen parent from insect visitation from before it opens until the pollen is collected. After two or three days the cover over the seed parent flower should be removed and the seed allowed to develop to maturity. The seed is then handled as described on page 52.

This procedure insures accuracy of operation, but some of the steps are often omitted. The protection of the flowers of the pollen parent is not always provided for, and even the protection of that of the seed parent in daffodils may be neglected in case the variety does not seed naturally in the locality. Such omissions save much time and enable one to make a larger number of pollinations. It is always a question whether more seed made or greater accuracy in its making is the more desirable.

The production of daffodil seedlings of quality is a slow process. One can not expect to see a single flower sooner than the fourth year, and it will usually be the fifth before many will be grown sufficiently. Then comes the exercise of judgment as to the desirable individuals and the courage to throw the rest away. Only a very small percentage of the seedlings are commonly worthy of even a second trial; 1 in 100 or even 1 in 1,000 may be a common ratio.

Commonly after the grower has made his selections of seedlings and grown them to the sixth or seventh year from the sowing of the seed, a second elimination becomes necessary, and still more must be discarded for reasons that were not apparent at the first blossoming. It consequently takes six or seven years for the breeder to be sure of the real character of his new seedlings. It is not at all surprising if he grows 1,000 to get 1 worthy of propagation.

At the end of six or seven years the breeder has one bulb which may be two to four nosed. He is then ready to begin working up stock, for, be it remembered, a variety of daffodils is obtained by vegetative reproduction from one seedling. If he continues the growing for 25 to 30 years and gets a doubling of the number of bulbs annually, he may reasonably expect to possess about 1,000,000 bulbs under favorable conditions. Such operation, however, does not usually take place. More commonly the producer begins selling at a high price when the stock has been worked up to a few dozen.

The seed of the daffodil should be planted soon after it ripens. At the United States Bellingham Bulb Station it is planted in August following its maturity the last of June or early July preceding. Its viability is reduced if the seed is held for spring sowing, and if kept a year, less than 50 per cent germinates. Again, much of it may not come up until the second year after planting.

It has been the practice there to plant the seed about 100 to 3 feet of row with the rows 3 to 6 inches apart. One inch deep is about right, and a coarse mulch should be provided to prevent disturbance of the soil during the winter. This should be removed before germination takes place in the spring, so as not to interfere with the plants coming up.

The young plants will die down in late June and should be covered with one-half to 1 inch of additional soil, which is left on during the second year. A mulch, again to be removed in the spring, is applied the second winter. At the end of the second growing season the bulbs should be removed from the seed bed to another location where they may be spaced sufficiently to remain two more years, when they will be large enough to blossom.

Where the quantity of seed is small or where climatic conditions are such that it is impracticable to maintain proper moisture con-

ditions in the open field, it is better to put the seed in pots, pans, or flats, plunged in frames. Suitable moisture and temperature conditions can then be maintained. While it is probable that the bulbs will withstand a certain amount of freezing, it is vastly safer to see to it that they are beyond any possibility of being frozen.

## SOME VARIETAL PECULIARITIES

### GREEN FLOWERS

For some reason not well understood, there is a tendency for the flowers of several of the double-flowered forms of daffodils to turn green. The most notable case is that of Double Van Sion, which all through the eastern United States not only turns green, but the trumpet and perianth split to such an extent that the flower is of little or no value after the year of importation. Even the first year from the Netherlands a considerable percentage of the flowers often come green.

This indicates that Netherlands conditions are far from ideal and that even the Dutch, with generations of experience, are by no means able to produce the variety perfectly. It is reported that with them the percentage of green and badly split trumpets varies from year to year, as it does on Puget Sound. So far as it is possible to judge, there is little difference between the quality of the stocks of this variety from the Netherlands and those from Bellingham, Wash., when grown on soils adapted to them.

While it is not understood what causes such behavior, there seem to be several contributing factors. Heat and drought during the dormant period are possibly the most potent. Proper fertility and soil conditions, especially with reference to drainage and porosity, are also important. There seem to be indications that greater perfection is attained at higher altitudes. It is said that the variety requires heavy soil, but the Whatcom silts underlain by an impervious clay at a depth of 15 to 16 inches are not suited to it. A few indications have been seen which point to the suitability of the fine, fertile, porous, river-bank sandy silts of the Pacific Northwest.

Besides Double Van Sion, some of the double incomparabilis, and occasionally even the Double Campernelle, are offenders in this respect. At times Sulphur Phoenix and some of the other Phoenix varieties as well get quite green. Both Holland's Glory (Double Emperor) and Double Sir Watkin turn green very promptly in the Carolinas, but Double Horsfieldii has remained in good color in the District of Columbia.

After flowers of Double Van Sion have turned green in the eastern United States, it takes about three years to bring them back to the perfection of normal stocks in the region of Bellingham, Wash.

It is very evident that a great deal can be accomplished by selection in the maintenance of color as well as in perfection of trumpet. Both the perfect and half-split trumpets have merit. The characters, however, have not persisted under mediocre methods and poor soil conditions, and there is little certainty in making selections and trying to maintain them unless the cultural conditions are suited.

### VICTORIA SPLITS

Instead of dividing and making a large bulb 12 centimeters or more in circumference by the division of the mother bulb, bicolor Victoria will rather frequently divide into a large number of what are sometimes called ring splits or "horse teeth." (Fig. 37.) Eighty or more bulblets are sometimes formed from a single bulb. What really happens in this excessive propagation is a division of the bulb scales into numerous flat or angled, uncoated bulblets. Hollanders usually advise that such bulbs are "weakened" and should be discarded.

The first time such a propagation showed itself excessively in the stocks of the Department of Agriculture was in a planting of large Victoria bulbs set in the fall of 1914 and dug in 1916. Of these, 15,000 were separated and planted about 50 to the row in August, 1916. In two years they had reached 8 to 13 centimeters in size. To insure flowering it was found that a 12-centimeter bulb was necessary, although an 11-centimeter one would usually blossom, but not always. Subsequent years showed that these mostly split normally after they grow up to about 15 centimeters. This 1916 stock is still carried and is scarcely distinguishable from the parent stock or from selections of normally split bulbs made at the time.

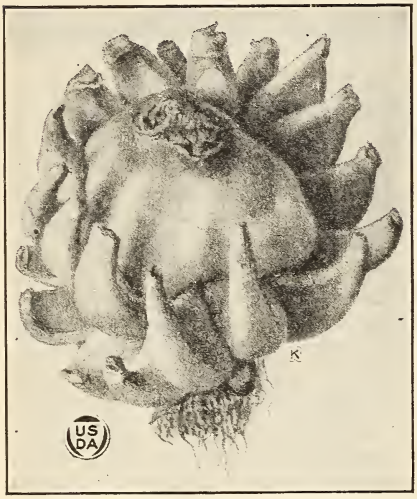


FIGURE 37.—"Horse-teeth" (excessive splitting) of the bulbs of Victoria

The objection to growing the small splits is the length of time it takes to do it. With proper fertility they can be planted 50 to the row and left two years. At this rate, 50,000 to 60,000 occupy only one-sixteenth of an acre. At the end of two years they can be dug and reset 14 and 21 to the row, and at the end of another year they are marketable as single-nosed bulbs. When space, labor, and scarcity of stock are considered, it is not at all certain but that it will pay to grow small splits rather than throw them away. Of course, when the ring splits are very prevalent in any stock they can not be marketed, and whether or not a grower plants his small splits will depend on whether he considers it more economical to take the regular smaller number of large offsets or the larger number of small ones with a longer period for their development.

The desirable thing, of course, and the thing to be striven for, is a stock in Victoria in which the bulbs divide normally by giving large splits which will round up into single-nosed flowering bulbs in one year.

The cause of the excessive splitting has been something of a mystery. Victoria and Paperwhite behave in this way. While the cause of the phenomenon is not understood, control measures are sufficiently

worked out to reduce the difficulty to a minimum if not to eliminate it. The formula for the control seems to be deep planting and good fertility, with always an emphasis on the phosphoric acid and potash elements, especially the former.

## VARIETIES AND CONDITIONS REQUIRING CARE

Care should be the watchword in handling all daffodil bulbs, but the grower will soon learn that some varieties are much more easily bruised than others. Those that have suffered most from rough treatment at Bellingham have been Madame Plemp and Horsfieldii. In one instance 75 per cent of the large bulbs of the first mentioned rotted from too vigorous use of the shaker. Digging was done when the ground was rather wet. Soil clung to the bulbs badly, and consequently the effort to get it off in the shaker proved disastrous. Van Waveren's Giant has been somewhat tender in the same way.

In the eastern part of the United States and other regions having hot summers, special care is necessary with the bicolor trumpets. Victoria has practically disappeared in all the warmer regions. Thorough aeration, quick drying, and careful handling so as not to bruise the bulbs will accomplish wonders. The variety has been successfully grown for three years in Virginia and one year in North Carolina with negligible losses.

A word of caution regarding rough handling in general should be given, because there is a tendency among all growers to disregard it.

## DIFFERENCE IN COST OF VARIETIES

The method of sizing and planting designed to get an even distribution of plant material on the ground has been given in detail on another page. The larger the bulb, the more space must be given to it for development. As an illustration, the planting stock of Empress is very large and must be set 7 to 9 and not more than 14 bulbs to a row, while the planting stock of Pheasant's Eye in experiments in 1919 was all set 21 bulbs to a row. In both of these cases merchantable stocks were produced. In the case of Empress planted 9 to a row the turn-off could not have been more than 9 bulbs, but in the case of Pheasant's Eye it was 21 bulbs or more, or two and one-third times as many. Many comparisons of this kind are possible. The fact that a variety produces a large bulb makes it comparatively expensive to grow.

Another cause of expense in varieties is paucity of reproduction. Desirable varieties that reproduce slowly must be high priced in comparison with those that give abundant increase. The white trumpet, Madame de Graaff, reproduces abundantly, while Peter Barr is shy with its offspring and is also a larger bulb. The latter, if for no other reason, must remain high priced, while the former is a cheap bulb.

King Alfred, for instance, although a good reproducer, must remain a comparatively expensive bulb to grow and force on account of its size. It occupies much more room in the field and about twice as much in the flats as normal-sized Golden Spur.

## CUTTING THE FLOWERS

The production of marketable daffodil flowers from outside plantings is an industry that has existed in this country for a long time. Southern Illinois, tidewater Virginia, the bay region near San Francisco, Santa Cruz, Calif., and to a lesser degree many scattered localities tributary to the large cities have harbored such an industry.

The ventures have proved rather profitable in the past, when stocks were limited and there were but few persons engaged in the business. However, with an increasing number of plantings and the likelihood of flooding any flower market in the country if bulb producers proceed to cut flowers generally, it is problematical just what the future has in store in this line.

On bulb production the effect of cutting off the flower is small. There is some effect, however, because the daffodil stem functions like a leaf. If it is estimated that the stem has half the elaborating surface of a leaf, then the stem represents to the plant one-seventh or less of its entire food-manufacturing capacity. But there is a fallacy in this reasoning, because a plant makes up for a large part of any such deficiency due to removal of its functioning stem area. Besides, the polyanthus grower is very familiar with the growth of 2 feet made by the stem when cut close to the ground as the flowers open. There are no definite experimental data on the subject, but it is doubted whether the loss to the bulb from cutting the flower is over 5 per cent, if, indeed, it is as much as that. Some have estimated it at 10 to 13 per cent.

The largest production of out-of-door cut flowers in this country has been from the cape section of Virginia. This has really been a unique development, conceived originally by a shrewd business woman assisted by her nephew, a commission merchant in Baltimore, where a large percentage of the crop was marketed.

The flowers there were pulled (not cut) from naturalized field plantings of Spurius (Trumpet Major), and allowed to run to grass after one or two years of culture. In the last five years the business of the general region has been placed on a bulb-producing basis, but the cut-flower industry is still pursued, and Spurius flowers are placed on the market in late February and early March from outside plantings.

The flowers in this region are cut (pulled) when well opened and are stood in water for a few hours before being packed. The blossoms are tied in bundles of 25 and stood upright in market baskets which are covered with cheesecloth. The greater part of the product is loaded on the boat in the evening and arrives at destination in the morning in prime condition. (Fig. 38.)

This method of cutting and packing answers very well when the distance is short and the time of delivery prompt, especially with short-stemmed material. With larger varieties a different pack is necessary if the flowers are shipped open. The flowers are tied similarly, but in smaller bundles, with the flowers all facing one way. They are then packed in flat boxes with faces up, a row in the end, then another row just below on the stems of the first. The other end of the box may be packed similarly, but in the reverse manner, so that nearly the whole box is a solid mass of flowers facing upward. One

or more ties are placed across the stems to prevent shifting. This method answers very well for flowers that are to be used immediately.

Most daffodil flowers for long-distance shipment are cut before they open, not only because they keep longer but because the packing is so much less difficult. Figure 39 shows a cut standing in water in preparation for short-distance delivery by truck. Such a cut will all open the next day and be in condition to give the

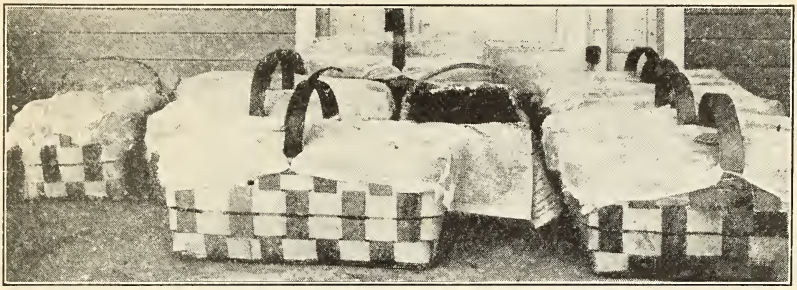

FIGURE 38.—Form of pack employed in getting daffodil flowers to the market from the cape section of Virginia

purchaser the benefit of the full life of the flower. If shipment is made by mail or express, the cut should be made even earlier—not later than the first rupturing of the sheath.

Most daffodil flowers will open in water even if cut a day or two before the sheath is ruptured. At living-room temperatures they develop very rapidly, but if retarded with reduced heat after opening they give their maximum of service. The flowers, cut early and

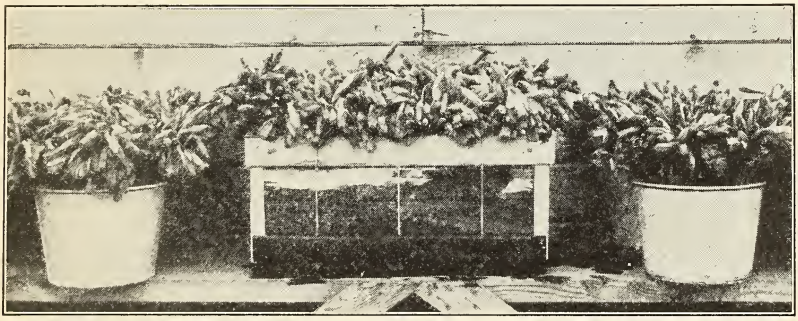

FIGURE 39.—Preparation of cut daffodil flowers for near-by markets in the Puget Sound section

opened in this way, are seldom as large or as perfect as when allowed to open on the plants. They are satisfactory, however, can be enjoyed for a longer period, and may be delivered with less trouble than if it were necessary to wait until the flowers opened on the plants.

The packing of unopened buds presents a minor problem. The cut stems are placed in water for two or more hours after cutting and then packed dry. The stems may or may not be tied in bundles, as one chooses. Each bundle may be wrapped separately in soft

paper and the whole bundle surrounded by waxed paper to prevent evaporation. The different bundles may be placed in the boxes or cartons tightly, so as to prevent shifting, for in tight bud they will stand considerable pressure.

## DAFFODIL SHOWS

The spring daffodil show is doubtless the best agency for the creation of local interest in this favorite flower. We have just begun to make effective use of this agency in this country. The development of interest by means of shows is to be looked for, but this result is only incidental. The value of the information disseminated about varieties and other features and characteristics of daffodils is priceless. In short, the daffodil show may be made a clearing house for the exchange of information among growers and fanciers.

The art of handling such shows so as to get the most out of them can only be acquired through practice. It requires a great deal of study on the part of committees arranging the details of such exhibitions to adapt the classes, prizes, and general arrangements to local conditions and available exhibition materials. It requires still greater skill so to plan that the show will develop greater completeness each succeeding season.

The arrangement of classes will be easily effected on the basis of the classification of the daffodil committee of the Royal Horticultural Society, which is now quite consistently followed. While there is little use in establishing classes of exhibits for such material which is not locally available, it may be desirable to include some such groups in order to stimulate interest and suggest lines of expansion, or the committees can suggest adapted groups which it would be desirable for exhibitors to acquire. Encouragement for the exhibition of unnamed seedlings should be given as soon as there is any possibility of obtaining them for the show.

The details of the staging of exhibits will vary with local preferences, availability of suitable vases, etc., but uniformity rather than diversity should govern in the stagings of any single competitive exhibition. The vases should be uniform and simple, and the exhibits should be viewed against similar background and lighting, else judgments can not be comparable.

The character and arrangement of the exhibition material should be clearly specified so as to attain as great a comparability as possible. This matter may vary, but it is usual for three flowers of a variety to be exhibited in a vase. (Fig. 40.) Foliage should be included, and preferably foliage of the same variety cut to show comparison with the stem. There may be objections at times to the cutting of foliage of expensive varieties; consequently it may be desirable to substitute that of some other.

The preparation of the flower for staging is an important matter. It is not easy for the inexperienced grower to get together in blossom varieties that naturally open at different seasons. No one can get the earliest and latest into blossom at the same time, but it is perfectly practicable to cover a large part of the arc of the blossoming period with flowers open at one time.

The preparation for this should begin at planting time the previous autumn. A great deal can be accomplished by planting later varieties in early situations in the garden. Northern exposure, shady situations, or areas that are cool for any reason will retard


FIGURE 40.—White trumpet daffodils, showing a method of staging for exhibition purposes. A, Madame de Graaff; B, Mrs. Camm; C, J. B. M. Camm; D, Peter Barr

the early varieties, and the opposite characteristics of location will slightly force the late varieties, thus making the flowering simultaneous or closer together.

When the blossoming season has arrived, and some time before the exhibition is to be made, more manipulations are possible to bring

together the varieties that blossom naturally at different dates. Here again the practice is to force the one and retard the other.

Blossoms that are going to be too forward may be cut young, shortly after the sheath has ruptured, placed in water in a cool, dark place, and kept in good condition for two weeks. On the other hand, late ones may be made to open earlier by placing them in a slightly warmer situation where the atmosphere is well saturated with moisture. The proper temperature having been provided, it is not difficult to arrange for the atmospheric moisture. Surrounding the vessels of cut flowers with a tube of absorbent fabric, having its lower end in water, will keep the atmosphere around the plants moist. If this is difficult to arrange, moistening the flowers three or four times daily with an atomizer will assist greatly. Shading the plants in the beds with burlap or other fabric will also serve to retard the development as well as the fading of the flowers.

Daffodil flowers develop best on the plant. All flowers manipulated by cutting and maturing otherwise are usually slightly smaller. Such manipulations are justifiable, however, for the purpose of having the flowers for certain dates, preserving delicate colors, and preventing soiling. All varieties with highly colored cups should be cut as they expand and kept in water and in a much subdued light in order to preserve these colors. In practice, exhibition flowers are mostly opened in subdued light inside.

In changing the flowers from the situation in which they grew to water in a cool place, it is well to bear in mind that the change should not be too great. If the weather is warm, say around 75° F., it would be a great mistake to cut the flowers and place them at a temperature of 45° or 50°. It would be safer to reduce the temperature gradually and finally hold them at 50° to 60°.

Again, some varieties behave differently when cut. The trumpet varieties commonly do not develop in size after cutting in the same proportion as do the poeticus varieties. Experience alone can teach the exhibitor which varieties to cut for development in water and which to shade on the plant for best results, but the experience is soon acquired.

## MALADIES OF THE DAFFODIL

The daffodil is rather free from serious parasites difficult to control. The bulbs and plants are somewhat poisonous; consequently many organisms shun them. Among the parasitic animal forms, however, are three which may become quite destructive unless controlled. These are the nematode *Tylenchus dipsaci*, the narcissus bulb fly (*Merodon equestris*), and the tarsonemus mite (*Tarsonemus approximatus*). The bulb mite (*Rhizoglyphus hyacinthi*) may also infest the bulbs, although it is of minor importance.

There are also various rots which give trouble under certain conditions. When the drainage is poor, the outer coats and often the bases of the bulbs become blackened and putrid, and the plants fail. (Fig. 41.)

In the Puget Sound section, especially on recently cleared land, bulbs that are injured by bad soil or other conditions are often completely permeated by the mycelium of hymenomycetous fungi, giving the impression of parasitism. (Fig. 42.) Often this same

mycelium may be found penetrating the outer coats of perfectly healthy bulbs as a white network of fungous strands. It is not considered parasitic.

FIGURE 41.—Narcissus bulbs showing various modes and degrees of deterioration due to bad drainage conditions

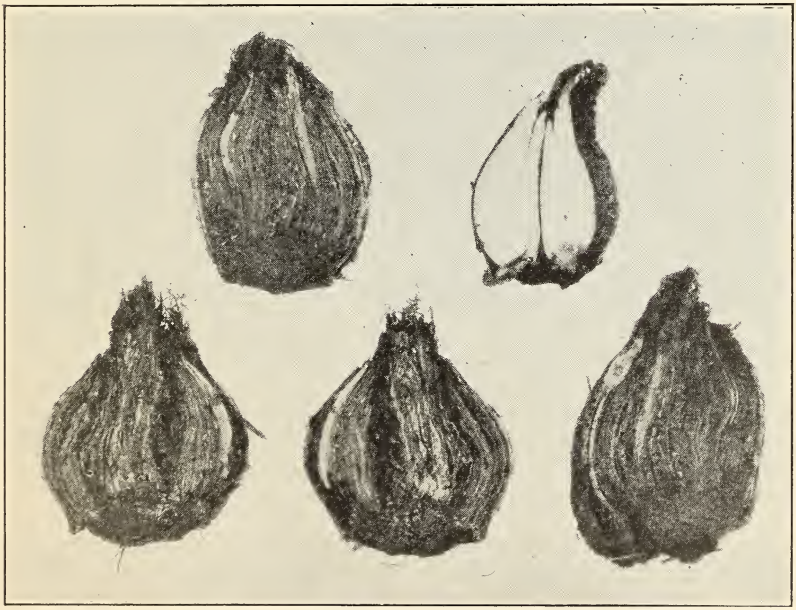

FIGURE 42.—Rotted bulbs of Madame de Graaff permeated with mycelium of forest fungi. Bellingham Bulb Station

### HOT-CLIMATE ROT

Possibly the most difficult malady of the daffodil to control is what may be termed the "hot-climate rot." The bulbs fail and turn to a light-chocolate color, the rot usually (but not always) progressing

from the base upward. This trouble is of little consequence on Puget Sound and in other cool climates, but is very serious on Dutch stocks on the Atlantic coastal plain. Polyanthus varieties are not usually affected unless allowed to heat of their own mass, which they will do readily soon after digging. Very serious losses have occurred from this cause in Texas, New Jersey, North Carolina, Virginia, and southern California. Indeed, this rotting of the bulbs seems to be the limiting factor in daffodil culture in warm regions. So serious have been the losses from this cause that at least two large growers have either quit the business or quit growing the most susceptible varieties. No variety seems immune, but some are much more susceptible than others. Golden Spur, Victoria, Emperor, and the bicolor trumpets generally, but not all of them, are particularly susceptible. The first two are so prone to the trouble throughout the Atlantic coastal plain from Philadelphia southward that their culture is no longer attempted to any great extent by the larger growers.

The secret of successful handling to prevent the losses from "hot-climate rot" is care in the treatment of the bulbs and continual planting on new land. The bulbs should be protected from bruising and should be dried promptly after digging. Success can not be expected with these stocks in warm regions if the handling is rough or if the bulbs are piled so high on the shelves that they remain somewhat moist for even so short a period as two days if the weather is hot. The malady is a storage trouble. Stocks may stand undisturbed indefinitely in perfect health and yet rot badly as soon as dug.

It is said that the Dutch growers habitually had serious losses from the same cause when they sent Golden Spur and Victoria to southern France to be grown a year in order to attain earliness. It is very evident that great care is necessary in the warmer portions of Europe as well as in this country. The reason seems to be the same in all cases.

### FREEZING INJURY

Freezing injury is likely to be looked upon at times as a disease. The evidence is dwarfed plants, leaves brown and dead at the tips, with an indistinct demarcation of the dead portion. Such a phenomenon is likely to occur on Puget Sound under poor drainage and ridging of the soil which allows penetration of cold from the side as well as the top. The bulbs of such dwarfed and injured plants will recover, but the recovery is expensive, for it takes about two years to bring it about.

### MOSAIC AND OTHER TROUBLES

There is a group of daffodil troubles which are referred to as broken, mottling, mosaic, yellow stripe, gray disease, etc. There is indication that some of them are virus diseases. On the other hand, it is more than probable that not all of the irregular distributions of the chlorophyll of these plants are really transmissible diseases. Some varieties are much more addicted to the trouble than others. Indeed, all the stocks of some appear to be imperfect in this respect, while others seem to become addicted to the trouble as they grow old. It is especially worthy of note that the mosaic condition is slow to

spread. The late Rev. Joseph Jacob testified that he could bring about the yellow stripe at will by excessive splitting apart of the bulbs. The whole thing is in a state of flux, but specialists are at work on the problem, with encouraging prospects.

For the present, since the mosaic plants and varieties are undesirable or less desirable than those of good color, the grower is advised to pursue the same practice with reference to them as with all virus diseases, namely, shun them, eliminate them from the stocks by roguing, or, if the whole stock is bad, get rid of it. This is the method of procedure with all true mosaics. Elimination of the affected individuals is the only recommended procedure.

Many varieties are particularly addicted to the trouble. Minister Talma, a recent variety, is mostly yellow striped. Conspicuus, Sir

FIGURE 43.—Sir Watkin, showing stage of development when roguing for mottling can be advantageously performed. This stock is about one-half mottled

Watkin, and Princeps are old varieties seldom entirely free, and the stocks that are pure in color must commonly be rogued constantly to maintain purity of foliage color. Sir Joseph Berkeley is an old variety which is seldom if ever free from the trouble, while some varieties like Double Van Sion, Empress, and Victoria seldom, if ever, have it.

The best time to detect the trouble is when the plants are 6 to 8 inches high and before they have flowered. (Fig. 43.) It is a good plan to go through the field at this time, row by row or bed by bed, to rogue out and discard yellow-striped plants. One of the serious features of the trouble results from the fact that it accumulates in the stock in inordinate proportion when the best bulbs are removed mechanically and the weaker and smaller ones are all planted. Unless the grower exercises care to rogue out these undesirables, he will soon find a predominating percentage of his stock yellow.

### NEMATODE DISEASE

At one time the nematode disease caused by *Tylenchus dipsaci* was a serious menace to the culture of daffodils abroad, but, since the elaboration of the hot-water treatment described on page 67, it is not at all a serious matter, for it can be readily controlled.

The most easily detectable symptoms of the disease occur in the leaves about the time of flowering. The leaves of the affected plants have swollen, hard, and commonly discolored spots in them. If they are drawn between the thumb and forefinger the hard lesions are very noticeable to the touch. Usually in mild and even in rather severe cases this is all the evidence there is, but in bad infestations the leaves and the stems become twisted and variously deformed in a characteristic manner.

The nematode trouble is commonly referred to in the literature as the "ring disease," because in an advanced stage of injury the bulbs often show alternate layers of decayed and healthy tissue when they are cut in two horizontally. This ringed appearance, however, is not an infallible guide or symptom, because the bulbs may decay in this way from other causes.

The rate of progress of the nematode disease from a slight infestation to a beginning of failure of the stocks has been rather slower than is commonly supposed. The spread and virulence of the disease are also much less than has been supposed.

The writer had experience with three infested stocks which functioned rather well for 10 years with a slight diffuse infestation before the bulbs began to rot to any great extent. The infestation was present when the stock first came under his observation; how long they had been infested is not known. The point of importance is that the stock grew and multiplied for 10 years before serious failures began. It is possible that more serious trouble might have occurred earlier in some other sections.

It may be accepted that even a slight infestation of the nema in daffodil stock will eventually engulf that stock unless clean-up measures are adopted. The progress of the disease may be slow, but it will be certain and, in the writer's opinion, will engulf the stocks in 10 to 15 years under the climatic and other conditions prevailing on Puget Sound. Fortunately this disease can be controlled by the hot-water treatment described on page 67. Soil that has become infested by the nema should not be used for daffodils for three years.

In the Pacific Northwest the common mole does a great deal of damage to the daffodil crop in some sections. It is doubtful whether the rodents ever eat any portion of the daffodil plant, but they frequently make their runs under the rows, cutting off the roots, and letting in air under the plants. This is very likely to be the case where bone meal and some other fertilizers are drilled in the rows. Methods of control of these pests are well worked out and discussed by Scheffer (*9*).

### BULB FLIES[4]

The larvae of the lesser bulb fly often inhabit decaying bulbs in large numbers, and although under favorable conditions they are said

[4] The information here given on insects has been approved by the Bureau of Entomology. In case further information on the bulb flies is desired, see Farmers' Bulletin 1362 (*11*).

by the Bureau of Entomology to attack sound bulbs, their abundance may be a result of injury from some other cause. The inexperienced grower, therefore, may be misled by the presence of the larvae of this fly in large numbers into overlooking the principal cause of the injury.

The narcissus bulb fly is at times and in certain localities a decided menace to the daffodil crop. The larva, or grub, lives in the bulb and destroys it, but usually not completely, for in the vast majority of cases there is formed a small offset or often two of them which perpetuate the destroyed bulb. (Fig. 44.)

The insect is a denizen of cool, humid regions. There is considerable question in regard to its survival for any long period in localities having hot summers. Although it was originally known to be present, the writer has failed to discover specimens in certain cultures grown for two years in Virginia and North Carolina. The horticultural inspector of San Diego County, Calif., maintains that the same conditions obtain in portions of southern California. On Puget Sound and in cool regions generally, the insect flourishes and does much damage, but is rather easily controlled or eliminated by several methods herein described.

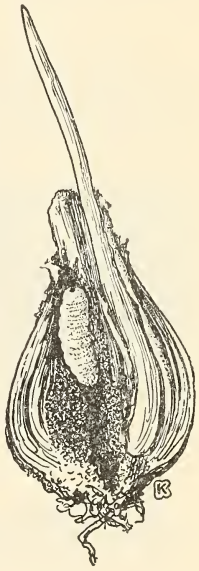

FIGURE 44.—A narcissus bulb containing a grub of the narcissus bulb fly which has destroyed the main bulb, but there is a narrow leaf from a newly formed bulblet which will survive

### CULLING

Culling has been the most universal method used and until recent years has been the main control employed by the Dutch growers. It consists in picking out the fly-infested bulbs at each digging. This can be done by the appearance, imperfection, softness, or lightness of the bulbs. The method, if carefully pursued, is a good control, but is looked upon as simply a palliative.

### ROGUING

Roguing is also an excellent control. It consists in gouging out in early spring the bulbs that have the grub of the fly in them. If the planting is carefully done, plants which fail to come up or which come with one or two weak leaves can be detected, gouged out, and the fly grubs in them destroyed. After a few trials one can detect the infested bulbs very accurately. This, although an excellent control, is also palliative, but with culling it forms an excellent check.

### SOAKING

Formerly soaking in water at atmospheric temperature for three days was recommended for fly control. Most of the grubs were driven out and could be collected and destroyed from the bottom of the vessel in which they were contained. In practice, though, it is found that many of the grubs simply stick their heads out and return to the bulbs when removed from the water.

### REPELLING

Tobacco powder spread thick enough for a distinct covering over ground and foliage, and crude naphthalene flakes at the rate of 400 pounds to the acre, have each been beneficial for a short time, but flies may be on the wing for two months. However, the flakes when spread thick around border clumps of daffodils and then covered with soil are excellent protection.

### KILLING THE FLIES

In past years at Bellingham, Wash., the flies have been on the wing from May 10 to July 10. During this period they may often be caught or killed. They are very lively in warm weather, but can be picked up by hand in cool, cloudy weather. This is also to be looked upon as an excellent palliative measure.

### HOT-WATER TREATING [5]

Immersing the bulbs in water held at a temperature of 110° to 112° F. for 50 to 60 minutes will kill all the grubs. No eggs of the narcissus bulb fly are involved; consequently the kill is complete. A better plan, when the treatment is for the fly only, is to treat for 1½ hours at 106° to 108°. It should be remembered, however, that if the stock is to move in interstate trade, the present requirements of the quarantine must be adhered to with a treatment of one hour at 110° to 111½° where this fly alone is concerned.

### CULTIVATING

Stirring the surface of the soil, and especially banking up the soil on the rows of daffodils a week or 10 days before the flies come out in the winged stage, will cover up many of the immobile pupæ so that the flies can not get out. This also serves to put the surface of the soil in such condition that the flies find it more difficult to oviposit in position so that the young grubs can reach the bulbs. Pupæ covered with 1 to 1½ inches of soil failed to emerge. Pupæ fully exposed to the sun for three days in Virginia died.

### DEEP PLANTING

Very deep planting has obvious mechanical and reproductive disadvantages; nevertheless there is an optimum safe depth which has commonly not been attained in the Northwest, as witnessed at times by winter cold injury. Deep planting seems to make for fly control in that it increases the fly's difficulties of operation. It is significant that bulbs missed in digging and subsequently put deep by the plow are not infested in subsequent years. It is also significant that this country got its importations of the fly from the Netherlands, rather than from France, where the planting is deeper and the summers hotter and drier.

### TRAP PLANTING

Shallow-planted areas scattered through daffodil fields are found to be worse infested where the fly is prevalent. This suggests shallow trap plantings which may be dug and destroyed or treated at the end of the season.

### FUMIGATION

A method of disposing of the larvæ of the various species of bulb flies by cyanide fumigation has recently been devised. The bulbs are inclosed in a tight container in which is also placed calcium cyanide at the rate of 12 ounces to 100 cubic feet for a period of four hours.

## THE TARSONEMUS MITE

A mite which has recently been described by H. E. Ewing of the Bureau of Entomology as a new variety, *Tarsonemus approximatus* var. *narcissi*, is parasitic on daffodil bulbs. It is an important and destructive parasite if allowed to accumulate in the stock, but since it succumbs readily to the hot-water treatment (hereafter described), it becomes of minor importance in commercial practice.

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[5] See also p. 67.

## THE HOT-WATER TREATMENT

The hot-water treatment prescribed by State and Federal plant-quarantine regulations for infested daffodil bulbs as a condition of domestic movement is 110° to 111½° F. for two and one-half hours where nemas are concerned and 110° to 111½° for one hour where only the larvae of the bulb flies need consideration. If the bulbs are to move in interstate trade, hot-water treatment therefore can not deviate from these requirements. Where, however, a grower is concerned with his own planting stock and desires to treat it for the purpose of eliminating infestation therefrom, he may heat the bulbs from 110° to 112° for three or even four hours if he wishes to make a more effective clean-up. On the other hand, all the benefits of the hot-water treatment aside from the elimination of the nema seem to be attained by a temperature of 105° to 108° for one and one-half hours with little or no floral injury.

The problem, therefore, in connection with the treatment is the maintenance of a constant temperature. This is well worked out for other industries, and application of the principles has been made in various forms to the treatment of bulbs.

The oldest machines to be used for treatment in this country were imported from England. (Fig. 45.) They consisted of cylindrical galvanized-iron tanks with a capacity of about one-half ton of bulbs. The tanks were equipped with a heater in the form of a coiled pipe placed in the bottom and connected with a steam or hot-water boiler, controlled by needle valves, and in some cases by a pressure-reducing valve in addition. About 10 inches above the heater a slatted false bottom was placed, and perpendicularly through the center of the tank a perforated tube was installed in which the temperatures were taken. This tube or pipe also controlled the drainage of the tank.

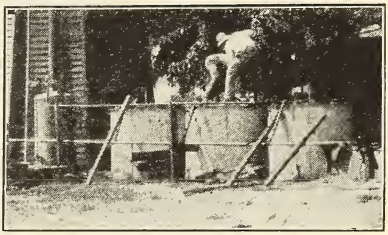

FIGURE 45.—An imported bulb sterilizer employing a battery of half-ton tanks

This simply constructed machine contains the essential features embodied in the more modern American developments. To this has been added one important element in this country, i. e., the agitator, which is essentially a marine propeller, with blades mostly of 6 to 8 inch diameter, operated by an electric motor. In all cases it is placed below the false bottom and serves to better unify the temperature throughout the mass of bulbs. Some machines have an auxiliary heater through which the water in the tank is forced by a pump operated by the same motor that rotates the agitator.

In 1926 the Department of Agriculture prepared for the use of bulb growers plans and specifications of a tank which may be used in the hot-water treatment of bulbs. Briefly, these specifications provide for a tank made of metal either with or without insulation in the form of lumber or other poor-conducting materials to prevent the radiation of heat. The essential characteristic of this machine is the automatic thermostatic controls, which consist of thermostats,

pressure valves, and air pumps operated on well-established principles. (Fig. 46.)

Other types of machines have been built for electric-current heating. These differ essentially from the previous ones in the one feature of heating by electricity.

The machine installed at the Bellingham Bulb Station is essentially a huge thermos bottle. (Fig. 47.) The rectangular tank of ½-ton capacity of bulbs is made throughout, cover and all, of 2½-inch lumber, which is a good insulator. Steam for heating is controlled entirely by hand valves and is delivered through a ½-inch pipe directly into the water through a noiseless water heater or steam muffler discharging in front of the propeller. (Fig. 48.)

This machine is commonly loaded with bulbs at a temperature slightly higher than the maximum. During the 5-minute loading period the temperature will drop to about 105° F. In a few minutes it is run up to 110° to 112° again and held there by simple hand-valve controls for 20 to 30 minutes, until the bulbs are heated through. The steam can then be entirely cut off and the propeller stopped. The tank will hold the temperature for 2½ hours with a drop of only about 1° in an atmospheric temperature of 70°. It is better, however, to push in the switch controlling the propeller motor for a minute or more about the middle of the period to prevent any possibility of stratification in the tank. The temperature is registered by a 15-inch cylindrical bulb thermometer inserted through an auger hole in the center of the cover.

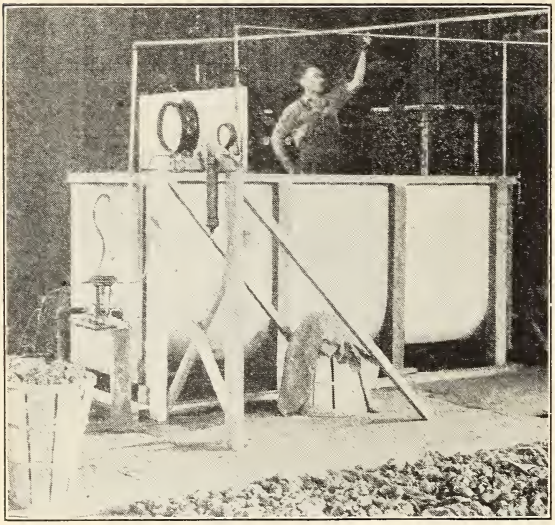

FIGURE 46.—Treating tank installed by the Wilmington, N. C., Bulb Growers' Association, based on plans drawn by the United States Department of Agriculture. The steam boiler, air pump, and propeller are not shown

The treating machines thus far considered are commercial in character and mostly of ½-ton capacity, although some are constructed to handle a ton at one time. They are, therefore, adapted to large operations. The small grower and the fancier who need to treat 1 or 2 bushels of bulbs at a time need smaller units and less expensive equipment. There are many ways in which the small grower can proceed, and many adaptations are possible if the simple fundamental principle is kept in mind. To meet this requirement one small treating unit has been installed at the Bellingham Bulb Station. (Fig. 49.)

The tank in this small machine is constructed on the same plan as that of the large one already described. The radiating surface in the bottom of the tank consists of two sections of a regular floor

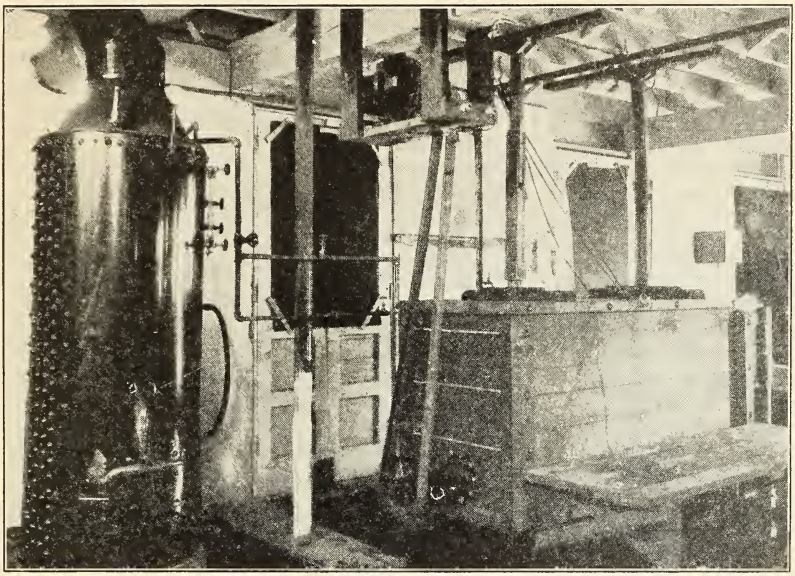

FIGURE 47.—The Bellingham Bulb Station sterilizer, which holds the temperature in a manner similar to a thermos bottle

radiator such as is used in house heating. This is connected by ¾-inch flow and return pipes with a single section of an identical radiator around which is constructed a small brick furnace, as illustrated in the figure. Two valves control the flow and return. Between the heater and the valve on the return pipe there is inserted a "tee" connecting with an expansion tank.

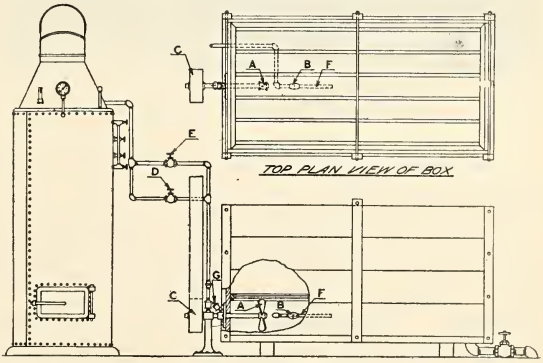


FIGURE 48.—Plan of the Bellingham Bulb Station sterilizer: A, propeller; B, injector; C, propeller pulley; D, needle valve; E, globe valve; F, a 10-inch piece of 1-inch pipe; G, grease cup

This small machine, capable of holding 1 to 2 bushels of bulbs, has no agitator, but otherwise it does not differ from the larger machine previously described except that it is heated by hot water instead of steam. It is operated in the same way, but, owing to the small bulk of water, it does not hold the heat so well. It may, therefore, be necessary to admit more heat once or sometimes twice during the 3-hour period. There are many ways in

which the small grower can maintain uniform heat between 110° and 112° F. in small machines. The better the insulation, the easier this is accomplished.

The material for this machine cost less than $20. It would be more satisfactory, but a little more expensive, to substitute a tank heater for the crude furnace. If the kitchen range with its water back is conveniently located, it can easily be connected with such a tank if the grower is equipped with a few pipe tools. The main thing is to have the tank well insulated. If gas is available, the problem is very much simplified.

The bulbs are loaded into the tank in all of these machines in wire baskets especially constructed to economize space, or in loosely woven burlap or other cloth sacks. There is probably a little better circulation with the wire baskets, but the sacks seem to be perfectly satisfactory. It is understood that the sacks are mostly used in both the Netherlands and England.

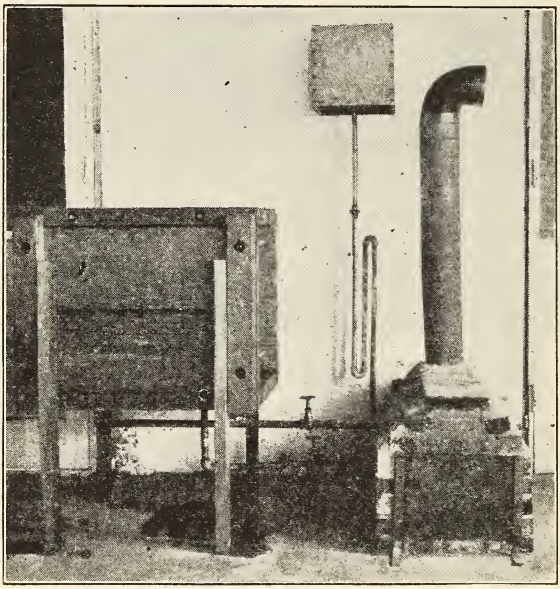

FIGURE 49.—A small, cheap, water-heated sterilizer at the Bellingham Bulb Station

The temperature must be kept between 110° and 112° F. during the entire 3-hour period. A lower temperature may not kill the nemas, and a higher one is in danger of injuring the bulbs. However, a temperature of 1° higher for a short time will seldom produce more serious effects than temporary floral injury and some leaf distortions for one year only.

Fully as important as this treatment is the after treatment of the bulbs. As soon as the treating period is up the bulbs are removed from the tank and spread out thin in a situation where there is free circulation of air, so that cooling will take place promptly. Sometimes it is advised that the baskets or sacks be plunged into cold water or be syringed with the hose. This is considered severe treatment and is not necessary. It is probably safer to spread the bulbs out thin to cool more gradually in the open air.

The bulbs should not only cool promptly but should dry without any delay. This is important everywhere, but more especially so in warm regions, where rotting is prone to occur if there is neglect of either of these factors. The advice given at times, to plant immediately after treatment, is likely to be misinterpreted in that

when the bulbs are removed from the tank to the field there may be sufficient delay to cause injury before they are spread out and cooled. "Promptly" should mean exactly that. The bulbs should not remain in the containers even overnight. A few hours in hot weather may do damage.

How soon treated bulbs should be planted will depend largely on conditions. If the weather is hot and the ground wet, the stocks will be much safer if dried thoroughly before being planted.

The time at which bulbs should be treated bears an important relation to the time of digging. Injuries may occur if treatment is too early. The bulbs should dry on the shelves for 3 to 5 weeks before treatment when the minimum injury to the flowers is desired. Treatment about 2 weeks after digging is quite satisfactory for planting stock. However, there will be more malformation of the flowers than if it is done later, but the foliage need not suffer.

The change of water in the treating vat is of much practical importance. The frequency of the change will depend on a variety of conditions. If the bulbs are thoroughly worked over and cleaned, it may not be necessary to change the water so often as it will when the processing occurs while the bulbs bear considerable soil and débris. Again, if there is a great deal of rot which has not been thoroughly eliminated in the stocks, a more frequent change of water is advisable for obvious reasons.

Generally changing the water once a day is sufficient. Often it may be practicable to have a good head of steam on as the last batch comes off at night. This may be turned on to heat the water up to 150° to 180° F. during the night, thus effecting a sterilization and obviating the necessity of changing the water more often than once in two days.

Adapting the hot-water treatment to different sizes of bulbs because of the variable time which it takes to heat different-sized bulbs through has little application in practice. An attempt to make such an adjustment would necessitate more careful sizing than is usually practicable and always sizing before the treatment is applied. The matter is too complicated for practical execution. The best plan is to adopt the standard period and give it to bulbs of all sizes, keeping in mind continually that prolonged treatment is safer than too high temperature.

The hot-water treatment, while designed to correct parasitism, seems in some cases to have other advantages. Stocks of certain kinds seem to be especially benefited by it. While some stocks do not blossom so well the next year, the vast majority are improved in vigor, provided the bulbs have not been recently treated. The beneficial effect of the hot-water bath has not been so noticeable when the treatments follow each other at 1 or 2 year intervals. This is thought to be due to the elimination and subsequent slow recurrence of the recently discovered Tarsonemus mite.

Experience in this country is not extensive enough as yet to warrant the listing of varieties that are or are not benefited by the treatment given more frequently than parasitism necessitates. Two years of experience at the United States Bellingham Bulb Station shows quite conclusively that Golden Spur stocks have been benefited by two treatments in successive years. The same seems to be true of

Double Van Sion. This corresponds with reports from the Netherlands, where it is understood that stocks receiving hot-water treatment oftener than is required by parasitism are treated at a slightly reduced temperature and for a shortened period, commonly a temperature of 106° to 108° F. and a period of about two hours being employed. This will accomplish all benefits to be secured from the treatment except destroying the nemas.

It seems more than probable that a still wider application of the hot-water treatment will eventually be made. Already one or two growers claim benefits from the inclusion of a small quantity of formaldehyde in the treating vat. The use of some of the organic mercury compounds seems to bear promise.

The hot-water treatment of the bulbs, even when the temperature is not carried above 110° to 111° F., usually causes some modification in


FIGURE 50.—Great Warley flowers: A, Treated for three hours at 111.6° to 110.4° F.; B, check

the flowers, but if this temperature is applied after a proper period of curing, these modifications are usually slight but vary with the variety. The higher the temperature the more pronounced the modification. The petals become slightly contracted (fig. 50), especially toward the distal one-half or two-thirds, and there is commonly a notched condition where the slight dwarfing begins. The fluting of the trumpet mouth is prone to be more or less modified. In extreme cases there is a very pronounced dwarfing, and there may be complete "blindness" with either a blasting of the flower or a failure of the scape to emerge.

An occasional effect on the foliage is characterized by the spotting of the tips of the leaves to a more pronounced disturbance of the coloring matter, resulting in a decided mosaic effect, covering an inch or more of the distal portion. In other cases there is a pronounced disturbance of the palisade cells of the leaf, rendering its surface papillate-roughened in long lines which may unite to form irregular areas. When only a few lines occur, the effect is not so

noticeable, but in bad cases the leaves become distorted, thickened, bent, and twisted.

While a lengthening of the time of treatment is safer than an increase of the temperature, even a lengthening of the time may cause conspicuous although not seriously injurious effects. In one case King Alfred bulbs very slightly infested with nemas were treated in season at 110° to 111° F. for four hours with no leaf injury observable in either field or flat, but the flowers were very badly deformed. Treatment of this variety similarly late in the season had a pronounced effect on the foliage, but only slight injury to the flowers.

The hot-water treatment, designed originally to eliminate the nema, in some cases accomplishes more. It destroys all other known animal pests. Investigators have observed benefits in the vegetative vigor of treated bulbs beyond the expectation from the elimination of the flies and the nema, and it has been supposed that some physiological changes are brought about by the treatment. It has recently been found that the Tarsonemus mite is also eliminated by the treatment, and this accounts for a very large part at least of what has been looked upon as a residual benefit.

Only planting stock should receive hot-water treatment unless the demands of interstate movement require otherwise. It is now thought that benefit occurs from treatment of such stock every three or four years, probably owing in large measure to the depredations of the Tarsonemus mite. However, in the absence of nema infestation, a temperature of about 106° to 108° F. continued for two hours seems to be ample.

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